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To enable those not already readers of THE ELECTRICAL WORLD to become acquainted with it, we will for $1 mail a copy of the paper to any address in the United States or Canada, postage prepaid, from the receipt of the subscription up to and including the issue dated January 5, 1889.

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CONVENTION NUMBERS.

The present issue of THE ELECTRICAL WORLD, containing a full report of the telephone convention, consists of no fewer than 56 pages, and appears immediately after the close of the proceedings, being, therefore, again first in the field and more than a week ahead of its date. It deserves mention, we think, as an evidence of the rush and pressure of the past two convention weeks that in the space of 12 days—between the two Sundays—we have published three numbers, making a total of no fewer than 176 pages. When it is remembered that this work has to be done amid the countless calls and duties of business and pleasure peculiar to such a time, and that, in addition, there were printed four editions of our daily bulletin of the electric light convention, it will be seen that the achievement may rank with others that have signalized the progress of electrical journalism.

The British Association. A GREAT many of our readers are naturally interested in the work of the British Association, and they will, therefore, be glad to see our special cable dispatch on the next page, from Bath, giving an account of what has been done, and an outline of the electrical work as a whole.

Dead Wires. WHATEVER may be the alleged shortcomings of the New York Board of Electrical Control they certainly merit the appreciation of the public and of all companies operating overhead wires, in the removal of dead wires from the streets of this city. It may seem strange, but it is a fact, that investigation has shown that entire pole lines with their wires are not used, and that their ownership is even disclaimed by the reputed proprietors. The latter evidently consider it cheaper to allow their old material to be confiscated than go to the expense of removing it. The discussion on the subject of dead wires at the Telephone Convention leaves no doubt that they are a most fruitful cause of trouble and even danger, and that it will pay telephone companies to remove all dead wires from their poles unless there is immediate prospect of their being called into service again.

Static Electricity and Incandescent Lamps. A CONTRIBUTOR in another column draws attention to his experience with the effect of static charges on incandescent lamps, and confirms the reports of the destructive effects of such discharges, as noted recently in these pages. The remedy suggested, that of connecting the tip of the lamps to ground, while effective, may, however, introduce a danger which would, under certain conditions, make the remedy worse than the disease. The connection of the lamps to ground if the rest of the circuit were perfectly insulated, would involve no danger, but the formation of a second ground on the circuit might lead to a short circuit and its serious consequences. Hence we have deemed it advisable to draw attention to this fact so that the danger may be avoided. A safety fuse placed in the circuit of the ground wire would be a necessary addition to it.

Electrical Measurement. THE paper read by Dr. G. A. Liebig, Jr., before the electric light convention, deserved more attention on the part of the members than it received. This was not on account of any short-coming in the paper itself, but was probably due to the fact that the members of the association and electric lighting people generally are not yet fully alive to the importance of obtaining and maintaining exact measurements and constant conditions in their services. Dr. Liebig described in very simple ways the methods by which these desirable objects could be attained, and, while he did not enter into the details, he pointed out in a very clear manner the general methods to be employed and the best ones to use for any particular purpose. Electric light station superintendents would do well to study this article carefully, for, with the suggestions therein carried out practically, much valuable information and economy in operation can be realized.

Disruptive Discharges in Underground Cables. WHILE the experience already gained seems to point to the fact that underground cables may be used as conductors for carrying arc light circuits, it has also shown that this method, when lead-covered cables are employed, is liable to be subject to interruptions on account of the disruptive discharges which pierce the lead and allow moisture to enter, thus causing grounds. This was clearly shown, especially by Mr. Sunny, of Chicago, in the discussion of this subject before the electric light convention. Mr. Acheson's treatment of the subject, therefore, and the studies which he has made on this trouble are of exceeding value at the present time, when our own subways are having their first arc light cables drawn into them. The results that he has obtained would show that with suitable precaution the chances of a disruptive discharge taking place can be considerably lessened, if not altogether prevented, and hence it would appear, in the light of the experience gained, that these new cables ought to be provided with some device of the nature described by Mr. Acheson.

Electrical Education. MUCH credit is due to Mr. E. R. Weeks for the able and painstaking way in which he has sought to bring before the National Electric Light Association the necessity of educating the *personnel* of the electric light station to an appreciation of the importance and the nature of its duties. A station may be operated without serious detriment with the aid of men who know little or nothing beyond their mere routine duties; but a time may, and usually does, come when in an emergency a little knowledge beyond the routine can effect the saving of thousands of dollars in repairs, or prevent a disaster. Therefore, aside even from the philanthropic idea which pervades the noble work of Mr. Weeks, the ultimate gain to a company in economy and reliability of operation, due to the management of intelligent workmen, will well repay the time and money spent on such an undertaking. As a supplement to the paper read by Mr. Weeks on the same subject at the Boston convention a year ago, that read at the late convention will give station managers a very good idea of the requirements of the case.

Induction on Telephone Wires. THE largest part of the time of the Telephone Convention was occupied in the reading of papers and discussion on a subject which is assuming greater prominence day by day. As long as the electric light circuits were utilized only at night their distributing effects on neighboring telephone wires was condoned and considered of comparatively little importance, but the continuous operation of central stations during the day caused by the distribution of current for power purposes, as well as the introduction of electric railways, has emphasized the fact, that the time has come to put the well-known and approved rules for the prevention of interference into force. Mr. McClure's experiences in Richmond, as detailed in his paper, show what can be done at comparatively small expense without resort to an individual metallic return for each wire, and though his device may not be entirely new, he nevertheless deserves credit for again calling attention to it. The report of the committee of the German Elektrotechnische Verein on the subject of inductive interference, the concluding part of which we publish this week, is a good review of the subject, and worthy of attention.

Electric Light and Telephone Circuits. SHORTLY after the telephone industry had become well established, the introduction of the electric light made manifest the disturbing influence which the conductors carrying heavy currents had upon telephone circuits; and the cries of despair of the telephone managers at the annoyance were frequently heard. It did not take long, however, to discover a remedy for the evil complained of, and to-day the method of running electric light and telephone wires side by side without disturbance is well understood and generally put in practice. Nevertheless the report of the committee appointed to investigate this question in Germany, and the tests they have made in connection with it, are interesting as confirming the practice generally adopted here; and we would draw attention particularly to the results of their experiments with regard to the influence of the iron covering for underground cables in the prevention of induction between the conductors in contiguous cables. The committee, however, advises the separation, as far as possible, of the two kinds of conductors, and this also is, we believe, now recognized to be the better practice, in this country. It is interesting to note that the results obtained with continuous and alternating currents do not differ essentially, and that by the employment of what is known as the concentric cable, *i. e.*, one in which the outgoing and returning circuits are placed one within the other, immunity from all effects of induction is obtained.

Telephone Batteries. THE lively discussion which the paper read by Mr. Pickernell before the National Telephone Exchange Association raised among the members is sufficient evidence of the fact that this question is by no means one in which a finality has yet been reached, even after more than ten years of the practical operation of the telephone; but we think that the discussion brought out the main points in which improvement must be looked for in this direction. Mr. Pickernell pointed out clearly the great advantage in employing batteries of low internal resistance, and he was corroborated in his statements by others. The peculiar adaptability of the storage battery to this purpose is apparent, and the experience gained and tests now being made will make interesting reports for future meetings. As put by one of the speakers, the charging of the secondary batteries is by no means an insuperable objection to their employment for this purpose, and with the probable use which they will be subjected to, it seems likely that they will not require more attention than the Leclanché type of cell now usually employed. The only difference would be the replacing of a charged by an exhausted cell, instead of the replenishing, as at present required. Mr. Lockwood, however, made a valuable suggestion, in which he touched the improvement required, by recommending the construction of a larger size of Leclanché cell than is now generally employed. By such a construction the internal resistance will be reduced, while at the same time the advantages of the Leclanché type of cell will be retained. Here is a good suggestion for manufacturers of Leclanché cells. Mr. Lockwood also pointed out a difficulty which stands in the way of coupling cells in parallel in order to obtain low internal battery resistance. The unequal action of cells, however uniformly prepared, will in time cause a difference in their strength which must finally result in waste and ultimate destruction.

The British Association Meeting at Bath.

Special Cable Dispatch to THE ELECTRICAL WORLD.

BATH, England, Sept. 6, 1888.—The chief interest of the meeting centres in the Geological Section, and the number of papers on electrical subjects is small as compared with the last meeting at Manchester. Notwithstanding this, the discussion on lightning and protection therefrom, as expected, developed great interest.

Sir Frederick Bramwell's presidential address last night attracted a brilliant assemblage. The subject-matter of his address, though of little importance technically, was devoted to a glorification of the engineering achievements of the past and foretold the lesser importance of the steam engine.

The inaugural address of Mr. W. H. Preece, as president of Section G, on the "Age of Electricity," was an able summary of the achievements of the last thirty years.

Prof. Fitzgerald, President of Section A, in his inaugural said that the year 1888 would be ever memorable on account of the experimental demonstration by Hertz of the truth of Maxwell's electro-magnetic theory of light, Hertz having succeeded in producing alternations at the rate of 100 million per second, and thus obtained waves short enough to exhibit interference phenomena. He was confident that great extension would be given to the theory of the structure of the ether and to the vortex theory. To-day the graphophone and phonograph occupy the attention of the Physical Section. The phonograph is exhibited by Col. Gouraud and the graphophone by Mr. Henry C. Edmunds.

The time can be scarcely far distant when electricity will have a section to its itself, with its own president, recorder and secretaries, and such a change would doubtless tend to increase the general interest in the subject. At present the electrical papers are read either in Section A (Mathematics and Physics) or in Section G (Mechanical Science). This arrangement is naturally attended with the drawback that important papers are sometimes read at the same hour, and one or other has to be forgone. This year, however, as I have said, the total number of electrical papers is rather below the average, and falls considerably short of the number read last year at Manchester, on which occasion we were honored with the presence of so many leading scientists from Continental Europe and America.

On the other hand, there are on the present programme no less than four events of special interest to electricians. The first in point of importance was the joint discussion in sections A and G on lightning conductors. In the next place the presidential addresses in each of these sections have dealt with electricity.

The fourth event, of which I have spoken, is the evening lecture by Prof. Ayrton, F. R. S., on the Electrical Transmission of Energy. Two evening lectures are delivered at each meeting of the British Association, in which the latest teachings of science are brought before a general audience in familiar terms, and are usually reported verbatim in the leading newspapers. It is noteworthy that for several years past one of the topics chosen has always been taken from electrical science. Last year, at Manchester, it may be remembered that Prof. Forbes lectured on the Electric Light. This year Prof. Forbes' contribution takes the form of a paper in section G on the Westinghouse system of electrical distribution. In the same section Mr. Cowles had promised a paper on the electrolytic reduction of aluminium; but as he has since found himself unable to be present, Mr. R. E. Crompton will read a paper on the same subject. Mr. Bains is down for a paper on the employment of electricity in mines, and as he has had considerable experience in this direction his remarks will doubtless possess much practical value. In section A, Dr. O. Lodge, F.R.S., has a paper on the measurement of electric wave lengths, and Dr. Fleming will probably have something to say about alternating currents. This does not, of course, exhaust the list, but I think it will be found to cover the chief points of interest.

The Influence of Wires Carrying Heavy Currents on Wires Carrying Weak Currents.—II.

Considering the results obtained in Test 2, that of electric light and telephone circuits lying freely in the earth close to one another, it was considered desirable to make some additional experiments in order to decide what influence the iron sheathing of these cables had in reducing the induction between them. For these tests there was employed the following:

1. A copper conductor, asphalted, covered with lead and drawn into an iron tube.

I. An electric light cable armored with iron.

2. An iron-armored 28-conductor underground telephone cable (known as the Siemens "fan" cable).

II. A second electric light cable armored with iron, similar to the first.

3. A copper wire covered with lead, not asphalted, and not covered by an iron pipe.

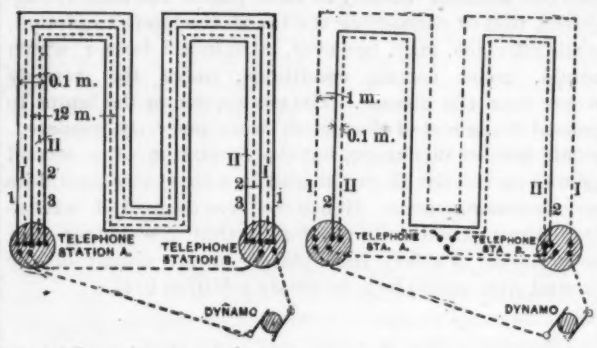
The electric light and telephone cables lay directly upon the ground, conductors 1 and 3 resting on wood. The lead sheath of these conductors was strengthened by copper wire in order to compensate approximately for the lead resistances of conductors 1, 2 and 3. Water pipes and two copper plates sunk into the ground served as the earth connections.

The length of each one of these circuits amounted to 400 metres, and their distance from each other was about 10 centimetres. Their grouping will be understood from the accompanying sketch, Fig. 5. Through the electric light cable I a continuous current of 150 ampères was sent.

Test 12.—When the lead coverings of the respective conductors or cables were employed as a return circuit (which arrangement was also employed in the test given later), no induction was noticeable in any of the telephone circuits (conductors 1, 2 and 3) and communication was faultless.

Test 13.—When the lead sheathing was connected to the telephone line or to the earth at either one of the stations *A* or *B*, a slight buzzing was heard in the telephone, which, however, did not interfere with communication.

Test 13 *a*.—By grounding at both stations, especially when the same ground was employed, the buzzing in the



FIGS. 5 AND 6.—INTERFERENCE OF LIGHT AND HEAVY CURRENTS.

telephones appeared with increased strength, and was sufficient to interfere with communication.

Test 14.—When a continuous current of 150 ampères was sent through electric light cable I in one direction, and returned in another direction through electric light cable II, there was no influence noted upon the telephone cable lying between the two electric light cables, even when the earth connection was used.

Test 14 *a*.—Neither was any influence noted upon the single conductors 1 and 3 with this arrangement.

Test 15.—If, however, the current was only sent through electric light cables I or II then the buzzing sound was far more marked in the single conductors 1 and 3 than in the telephone cable, so that communication was no longer possible. No essential difference as regards the amount of induction could be noticed between the bare conductor 3 and the asphalted and iron-covered conductor 1. Finally, in order to obtain a solution of the question whether the latter result would be essentially altered by (*a*) an increase in the distance of separation between the electric light and the telephone circuit; (*b*) a shortening of the length of the inducing electric light circuit, and (*c*) a decrease in the strength of the electric light current,—the following additional experiments were made which will be understood by reference to Fig. 6:

The resistances of the lead-sheath of the telephone cables and of the different earths used, were as follows:

Resistance of lead and iron sheaths of telephone cable	1.3 Siemens units.
Resistance between lead and iron sheathing of the telephone cable and the water-pipe (earth)	15.4 Siemens units.
A later measurement showed	23 Siemens units.
Relative resistances of the three earths employed: *a*. Copper plate of 0.25 square metre area, imbedded in ground water; *b*. Copper plate of 0.8 square metre area, imbedded in ground water, distant about 100 metres from plate *a*; *c*. Water-pipe.	
Resistance between *a* and *b*	55 Siemens units.
Resistance between *a* and *c*	43 3 Siemens units.
Resistance between *b* and *c*	13.4 Siemens units.

From these we get as resistance for earth:

a	42.6 S. U.
b	12.7 S. U.
c	0.7 S. U.

Test 16.—The length of the electric light cable II was the same as before (400 metres); also the distance between the two cables (0.1 metre), and the strength of the current in the electric light cable 140 ampères. By connecting the telephone cable with the same earth the strong buzzing note was heard in the telephone, which made communication difficult, although it did not entirely prevent it with distinct articulation. By employing different earths the buzzing note was decidedly weaker, and by using earths *a* and *b* it scarcely interfered with communication.

Test 17.—The length of electric light and telephone cable as well as strength of current remained unchanged, but the distance between the cable was increase to one metre. The phenomena were similar to those of Test 16, and the buzzing noise in the experiments was not so distinctly marked.

Test 18.—Cable length and distance the same as in Test 16. Current strength in electric light cable, however, reduced to 40 ampères. When using the same earth the buzzing was greatly weakened and no longer interfered with communication, and with earths *a* and *b* disappeared almost entirely.

Test 19.—The length of both cables lying next to each other was reduced to one-half, *i. e.*, to 200 metres, by the shortening of the electric light cable. Distance of the cables 0.1 metre, and current strength 40 ampères. The result was the same as that of Test 18. However, the buzzing in the telephone seemed to be still weaker.

Test 20.—Distance of the cables, 0.1 metre; length of electric light cable, 200 metres; current strength, 140 ampères. The phenomena corresponded to those of Test 16, the buzzing sound, however, being a trifle weaker. These experiments also proved that heavy currents have no influence on telephone circuits if the outgoing and returning leads of the electric light circuit are contained in the same cable or are close to one another, and provided the current is of the same strength in both leads.

The committee was furthermore of the opinion that no definite rule could be made for the minimum distance to be maintained between these two types of conductors. For technical reasons, as well as for the interest and safety of the telephone service, it would be advisable to increase this distance as far as possible. It was also deemed advisable to cover both kinds of circuits with a substantial protective sheath.

From these were derived the following general rules for the operation of electric light circuits in proximity to circuits carrying weak currents.

Alternating current circuits do not act disturbingly upon circuits carrying weak currents when the outgoing and returning lead of the former carry the same current strength and are equally distant from all circuits carrying weak currents, as is the case with the so-called concentric cables. The same arrangement is also desirable with regard to continuous currents; at any rate, the difference between the distances of the outgoing and the returning lead of the electric light wires, relative to the telephone circuits, as well as the difference between the current strengths of the outgoing and returning leads, must be only a very small one. No disturbance in the operation of circuits carrying weak currents takes place from the influence of heavy currents, when the outgoing and returning lead of the former (telephone) circuits are metallic, and lie close to one another. The committee consider, however, that for the safety of the telephone service it is desirable that underground electric light, and telephone and telegraph circuits be separated as far as possible from one another, and that the cables be covered with a protection against mechanical injury.

The Winding of the Baxter Dynamo.

To the Editor of The Electrical World:

SIR: Permit me to correct Mr. Robert S. Dobbie's "criticism" *in re* the resistance of the new Baxter generator, as per his note in your issue of Aug. 18.

His reading of the resistance as printed is correct. By some inadvertance, however, the decimal point has been omitted in the text, so that the resistance of the armature reads 64 ohms instead of .64 ohms, and of the field 70 ohms instead of .70 ohms. He will thus see that $R_a + R_m = 1.34$ (instead of 134), which, multiplied by $40^2 = 2144$ watts, the internal loss due to heating effect; $\frac{100000}{102144}$ gives 97.9 per cent. This corresponds with the loss of the "trifle over 2 per cent. of the total output of the machine," as mentioned in the descriptive article.

W. F. D. CRANE,
Ass't Electrician Baxter Elec. Mfg. and Motor Co.
BALTIMORE, Md.

German Silver Resistance Coils.

To the Editor of The Electrical World:

SIR: Will you kindly inform me (1) What size of German silver wire (in thousandths of an inch), and how many feet (or inches) I will require to make a coil of 1 ohm resistance. (2) Will I find any material difference in the resistance of wire of different makers? (3) Would it be a good plan in winding a coil to wind half of it in one direction and the other half in the other direction to avoid induction? D. T. GREENE.
BINGHAMTON, N. Y.

ANSWER: (1) A length of about 19 feet of No. 16 B. & S. German silver wire will give a resistance approximately of 1 ohm. That wire is a trifle over $\frac{1}{16}$ inch in diameter. (2) Yes; there is apt to be considerable difference in the wires of different makers and frequently in different samples of the same makers. (3) Yes; that is the usual method employed.—EDS. E. W.

Tenth Annual Meeting of the National Telephone Exchange Association.

The tenth annual meeting of the association was held at the Hotel Brunswick, New York City, Sept. 4 and 5, 1888.

The following gentlemen were in attendance during the meeting:

ALBANY, N. Y.—W. H. Cull, A. B. Uline.

ATLANTA, Ga.—W. J. Cole.

BRIDGEPORT, Conn.—F. A. Mason, H. D. Stanley.

BOSTON, Mass.—Geo. Albree, P. H. Alexander, F. J. Boynton, W. J. Denver, T. B. Doolittle, I. H. Farnham, C. J. French, F. W. Harrington, W. A. Hovey, N. W. Lillie, T. D. Lockwood, A. O. Morgan, R. F. Ross.

BROOKLYN, N. Y.—C. F. Cutler, E. G. Main, J. C. Reilly, W. D. Sargent, Prof. Plympton.

CHARLESTON, S. C.—J. D. Easterlin.

CHICAGO, Ill.—G. L. Beetle, C. A. Brown, F. E. Degenhardt, J. M. Jackson, W. A. Kreidler, C. E. Scribner.

CINCINNATI, Ohio.—A. D. Bullock, E. V. Cherry.

DALLAS, Tex.—F. B. Knight.

DENVER, Colo.—E. B. Field.

DETROIT, Mich.—F. A. Forbes.

EASTON, Pa.—W. Bampfield.

ELMIRA, N. Y.—W. N. Eastabrook.

HOUGHTON, Mich.—J. R. Dee.

KANSAS CITY, Mo.—C. W. McDaniel.

LOUISVILLE, Ky.—Jas. Clark, H. N. Gifford, J. B. Speed.

LOWELL, Mass.—C. J. Glidden.

MONTREAL, Can.—C. F. Sise, H. S. Thornberry.

MORRISTOWN, N. J.—J. C. Clark.

NEWARK, N. J.—C. O. Baker, Jr.

NEW BEDFORD, Mass.—Samuel Ivers.

NEW HAVEN, Conn.—E. B. Baker, T. A. Barnes, J. E. McConnell.

NEW YORK, N. Y.—P. C. Ackerman, G. W. Arnold, Jr.; W. H. Baker, C. H. Barney, L. F. Beckwith, D. I. Carson, J. J. Carty, J. C. Chamberlain, W. A. Childs, R. Crawford, C. F. Cutler, H. C. Davis, Thos. Delano, A. S. Dodd, Chas. Dutton, W. H. Eckert, J. W. Godfrey, H. Green, G. H. Guy, E. J. Hall, Jr.; M. M. Hayden, A. S. Hibbard, F. J. Hovey, C. A. Hussey, W. J. Johnston, J. F. Kelly, O. E. Madden, A. H. Mackinnon, E. B. McClees, F. A. Magee, G. T. Manson, T. C. Martin, J. C. McQuade, R. W. Pope, D. B. Parker, E. L. Perot, F. A. Pickernell, J. C. Pierrez, C. W. Price, W. R. Ryan, A. L. Salt, J. A. Seely, W. H. Sheldon, E. F. Sherwood, T. T. Smythe, J. E. Smith, H. L. Storke, C. E. Stump, J. B. Taltavall, H. B. Thayer, C. R. Truex, T. N. Vail, W. A. Vail, W. B. Van Size, W. T. Westbrook, J. A. Wetmore, Jos. Wetzler, G. L. Wiley, G. Worthington.

OMAHA, Neb.—F. Drake.

PARIS, France.—B. Abdank-Abakanowicz.

PHILADELPHIA, Pa.—David Brooks, J. M. Plush.

PITTSBURGH, Pa.—F. E. Degenhardt, Henry Metzger.

PROVIDENCE, R. I.—A. C. White.

RICHMOND, Va.—C. E. McClure.

ST. JOHN, N. B.—A. A. Knudson.

ST. LOUIS, Mo.—G. F. Durant.

UTICA, N. Y.—C. A. Nicholson, F. G. Wood.

WASHINGTON, D. C.—G. M. Brown, S. M. Bryan, J. E. Crondell, H. W. Upperman, Fred. W. Royce.

WILLIAMSPORT, Pa.—F. Bailey.

The Association was called to order at 11 A. M., on Sept. 4, by the President, Mr. Henry Metzger, of Pittsburgh.

The calling of the roll showed that there were present delegates representing twenty-six active companies forming active membership, two representing the corporations forming the associate membership and five honorary members.

The PRESIDENT: Gentlemen of the Association, I have the honor of introducing to you Mr. Henry C. Davis, President of the Electric Club, of New York city, who desires to extend on behalf of the Electric Club and of the citizens of New York a cordial welcome to the metropolis of the country. (Applause.)

Mr. DAVIS: *Mr. President and Gentlemen of the National Telephone Exchange Association:* On behalf of the Electric Club of New York I am here to confirm our invitation of a year ago and extend to you a cordial welcome to our club, and I trust that you will enjoy yourselves there to the extent that your predecessors of last week, I believe, have done. In extending our invitation to you, the intention was that you should hold your convention in our lecture room, but I am happy to congratulate you upon your numbers being too large to be comfortably accommodated in our limited quarters. I also want to congratulate you upon the fact that you have only one parent company to deal with instead of a conglomeration of parent companies, as the National Electric Light Association has, each believing that their own apparatus is the best and the one that you ought to adopt and use. You have to a certain extent a kindred interest with that association, and I trust that your struggle with the underground conduit system will be a success. (Applause.)

President Metzger, on behalf of the association, returned thanks to President Davis for the invitation extended. The application for membership of the National Conduit Manufacturing Company was then referred to the Executive Committee.

The secretary then read his report.

The resignations of the companies mentioned in the secretary's report as well as the honorary membership of the late Clark Insulated Wire Company were referred to the Executive Committee for action.

Mr. H. L. Storke, the treasurer, then made the following verbal report:

I have to report that the finances of the National Telephone Exchange Association are in a sound condition. The association enters upon the next year of its existence with a surplus of $21.85, the surplus of $37.28 of a year ago having been slightly reduced. It would not have been possible under any circumstances to reduce it more than slightly. I have here the vouchers for all disbursements. The receipts of the year have been $1,937.69, and the disbursements $1,953.17; that is, during the year the actual expenses have slightly exceeded the revenue. If it is the pleasure of the convention I move the reference of this report with the vouchers to the Executive Committee without reading the details. The motion was carried.

The minutes of the meeting of the Executive Committee held Sept. 4, 1888, were read by the secretary, and on motion were accepted.

On motion of Mr. Tyler, seconded by Mr. Sargent, Mr. Henry Metzger was unanimously re-elected president. In returning thanks for the same, Mr. Metzger said:

I can only thank you for this evidence of renewed confidence on your part in re-electing me to the office of president. It is usual on occasions of this kind for a retiring president—and in this case the same person is also to be president of the association in the ensuing year—to offer a few brief remarks upon matters germane to the purpose for which we have assembled. According to the constitution the object of the association is to collect, preserve and protect the various matters of importance to telephone interests, and how well this association has succeeded in executing this trust can be answered by referring to the telephone statistics of the day. Every city, town and village in your country, from the Atlantic to the Pacific, from the borders of Canada to the Gulf of Mexico, give visible evidence of the work you have performed in developing the telephone business. But I do not intend to take you back and recall the history of the past. It is sufficient for me to ask you to go to that period of time, one year ago, when we were assembled in the city of Pittsburgh. It was a time pregnant with uncertainties and doubts as to what the status of the telephone companies would be for the coming, that is to say, the past year, and probably for all time. It is true that every Circuit Court of the United States, wherever the American Bell Telephone Company had brought suit, had granted preliminary and final injunctions against infringers whether defended by government aid or by private wealth and influence. Yet there still remained a doubt as to what the final outcome would be. The glorious uncertainties of the law were too well known to all of us, and although our faith in the righteousness of our cause was firmly grounded, yet some unexpected resistance might develop that would weaken our faith in the wisdom, justice and honesty of men. After a long, bitter and expensive struggle the day of judgment came. It was delivered by that honest and eminent jurist, Morrison R. Waite, the late Chief-Justice of the Supreme Court, whose memory, I think, the telephonic fraternity should revere, and over whose grave we can all shed the tear of regret at his untimely death. But before yielding up his life he placed the seal of judicial authority on the scroll of fame that bore the name of Alexander Graham Bell as the inventor of the speaking telephone. (Applause.) And in this connection I cannot forbear saying to the association that we are much indebted to those two eminent attorneys, J. J. Storrow and E. N. Dickerson, for their masterly knowledge of the science of telephony and their keen analysis of the evidence as produced in the various causes which they argued. Since that time we have had a period of repose; a feeling of security has pervaded the minds of our stockholders in regard to the safety and permanency of their investments. In many cases the directors of companies have entered into a more liberal policy, one more in accord with the necessity and requirements of the business. In some cases, notably in New York, Chicago, Baltimore and Pittsburgh, new buildings have been erected suitable for carrying on the business in which we are engaged. In some other cases underground systems have been laid, either a new plant or extensions of existing ones. Multiple switch-boards have taken the place of old systems that were a constant source of discomfort to subscribers and telephone managers. In some other cases larger poles have been erected, copper wire has largely taken the place of iron and steel, and good insulation the place of poor or perhaps none at all. But while much has been done, much more remains to be done in the next three or four years, if the members of this association desire to retain control of the business which they have created and developed. In the sphere in which we move and perform our work we may be kings, but there is a greater circle beyond that in which a constant power is being exerted that will in a very short and limited time compel you—compel us all to give the best of service and at a cheaper cost, so cheap, in fact, that your competitor of the future may well hesitate at the threshold before entering the field with hopes of successful venture. But the day of the inevitable conflict is bound to come, and it is your bounden duty to your stockholders and in justice to yourselves to prepare for that day. The maxims, "In days of peace prepare for war," or "Make hay while the sun shines," are worthy of your serious consideration. It will not do for you to fold your hands and rest content with the fruits of the legal victories of the American Bell Telephone Company. The competitor of the future will be no less relentless than the infringer of the past; watching every movement that you make, noting every step of progress, he is but waiting for the day and the opportunity either to divide the business with you or perhaps to absorb it entirely. I now, gentlemen, desire to return again my thanks to the association for your very kind treatment of the chairman; in fact from the very time I first entered your midst at Niagara Falls to the present moment. (Applause.)

The following additional officers were then elected: Vice-President, W. D. Sargent; Treasurer, H. L. Storke (re-elected); to the Advisory Committee, M. F. Tyler (re-elected); to the Executive Committee, S. M. Bryan, W. J. Denver, G. M. Stone and C. F. Cutler.

Invitations were then read from the American Telephone and Telegraph Company, for a drive in Central Park; from the Western Electric Company, to a dinner after the drive, at the Mount St. Vincent Hotel; from the Metropolitan Telephone Company, to an excursion up the Hudson and dinner, including "Nero" at Staten Island. These, together with the invitation of the Electric Club, were accepted.

The following paper was then read by Mr. F. A. Pickernell on

NOTES ON TELEPHONE BATTERIES.

I shall not attempt in these notes to recommend or describe any particular battery, but shall content myself with pointing out defects existing in the batteries now commonly used for transmitters, and emphasizing the importance of certain features which all telephone batteries ought to possess.

The selection of batteries for transmitters has always been a matter of considerable importance, although not always recognized as such. When the battery transmitter was first introduced, nearly all telephone wires ran on overhead structures, no cables being used. The retardation in these circuits was consequently slight, and it was during this period of the business that the large margin in transmission was observed, it having been found possible to talk with the same ease over circuits 50 miles long as it had previously been over circuits a mile long. This led naturally to poor construction, lines being built with small gauge iron and steel wire and in many cases without insulators. Such construction cut down this margin of transmission to such an extent that it was found impossible to talk over such lines in bad weather unless the transmitter and battery were in the very best condition.

Better construction followed, and with better construction the battery problem was of less importance. More recently, however, the extensive introduction of cables has again cut down the *margin* of transmission. This, of course, renders it necessary to keep the transmitter and its battery in better condition. As the cable system of any telephone exchange increases, in a like ratio will the importance of the battery problem increase. It was only last week that a gentleman was telling me of his experience in confirmation of this. His company had a cable 2½ miles long, which not only had a high electrostatic capacity, but also a high resistance. This cable was used mainly for trunk wires. It was noticed that many of the subscribers who had no difficulty in talking with parties in their own exchange had considerable difficulty in talking with parties in the other exchanges connected through this cable. Upon inspection it was found that invariably a poor battery was found at the subscriber's instrument. This cable made a very good battery inspector, and one, I may say, that did not ruin the transmitter in inspecting.

The battery most commonly used for transmitters is of the Leclanché form. The little attention required by a battery of this class, its freedom from violent acids, the ease with which it is set up, its small consumption of zinc, there being no consumption when the battery is on open circuit, all unite in making it the leading form of telephone battery. However, it polarizes rapidly and has a high and constantly increasing internal resistance when worked over a low resistance circuit, as it invariably is when used for transmitters. The importance of low battery resistance is shown clearly by the following considerations.

The efficiency of any transmitter, other things being equal, is proportional to the variation in current strength produced in its primary circuit. The greater the variation in current strength the greater is the efficiency. The variation in current strength being proportional to the variation in resistance, it follows that the efficiency of any transmitter is proportional to the variation of resistance produced in its primary circuit. The following table, calculated for a Blake transmitter, shows how important is the part that the battery resistance plays in modifying this variation in resistance: or, in other words, in modifying the efficiency of the Blake transmitter.

This table assumes the variation in a Blake transmitter to be from 5 to 15 ohms, these figures being the result of many measurements.

TABLE FOR BLAKE TRANSMITTERS—RESISTANCE OF PRIMARY CIRCUIT OF INDUCTION COIL .5 OHM.

Battery resistance.	Minimum resistance.	Maximum resistance.	Ratio of min. to max.	Percentage decrease of ratio from that of battery of 0 resistance.
0.....	5.50	15.50	1 : 2.82	.....
.33.....	5.83	15.83	1 : 2.72	3.5
.67.....	6.17	16.17	1 : 2.62	7.1
1.00.....	6.50	16.50	1 : 2.54	9.9
1.33.....	6.83	16.83	1 : 2.46	12.8
1.67.....	7.17	17.17	1 : 2.39	15.2
2.00.....	7.50	17.50	1 : 2.33	17.4

Two ohms is not an uncommonly high resistance for a Leclanché battery, and from the table we see that the variation from its minimum resistance to the maximum resistance of the primary circuit of a Blake transmitter decreases from a ratio of 1 : 2.72 in the case of a battery of .33 ohm internal resistance, to a ratio of 1 : 2.33 in the case of a battery of 2 ohms resistance, or a decrease of 14 per cent.

With long distance transmitters the battery resistance is an even more important factor, as will be seen by the following table. This calculation for long distance transmitter assumes the variation in resistance to be from 4 ohms to 20 ohms with a resistance of the primary of the induction coil of .45 ohm. Three cells of Leclanché battery are generally used with this transmitter.

Battery resistance.	Minimum resistance.	Maximum resistance.	Ratio of min. to max.	Percentage decrease of ratio over 0 resistance.
0	4.45	20.45	1 : 4.60	.....
.33.....	5.45	21.45	1 : 3.94	14.
.67.....	6.45	22.45	1 : 3.48	24.
1.00.	7.45	23.45	1 : 3.15	32.
1.33.....	8.45	24.45	1 : 2.89	37.
1.67.	9.45	25.45	1 : 2.69	42.
2.00.	10.45	26.45	1 : 2.53	45.

From this table we find that the variation is decreased from 1 : 3.94 when batteries having internal resistance of .33 ohm are used, to a ratio of 1 : 2.53 when batteries of 2 ohms internal resistance are used. These tables likewise show why it is that even a slightly defective joint in the primary circuit prevents the action of the transmitter.

Polarization is a defect of even more importance than internal resistance. It is not uncommon for a Leclanché battery to decrease 30 per cent. in E. M. F. after 10 minutes' use. This of course decreases the average current in the primary circuit of the transmitter in a like ratio.

Having noticed now the importance of low and constant internal resistance and constant E. M. F., I will next call attention to some of the causes which operate to render telephone batteries not only poor to start with but unreliable in service. Lack of porosity in the porous cups is frequently the cause of high battery resistance. Commonly porous cups are found which contain peroxide of manganese dust. This dust should never be admitted, as it invariably increases the internal resistance. The peroxide should be in particles about the size of small

peas. Binding posts are frequently found which do not make good connections with the electrodes. The binding post on the carbon plate is often found after a few months' use to be almost entirely insulated from the plate. This is caused by the salts creeping up through the carbon and corroding the metal binding post. The upper portion of the carbon is supposed to be entirely impregnated with paraffine to prevent this crawling, but very often the carbon is not soaked long enough to become thoroughly saturated. Care must be taken not to use an excess of sal ammoniac in setting the battery up, for otherwise crystals will form on the zinc, increasing very much the internal resistance. If the sal ammoniac becomes impoverished chloride of zinc will deposit in the same manner.

A poor quality of the peroxide of manganese is frequently found in porous cups. When such is used polarization takes place very quickly. Gravity batteries and bichromate of potash batteries have been used to a considerable extent, especially for long-distance transmitters. These batteries require much more attention than the Leclanché battery and are not so reliable.

The battery which in its electrical properties approaches more nearly the ideal battery is the storage battery. This combines constant E. M. F. with very low internal resistance. Two cells of storage battery on a long-distance transmitter give the very best transmission. This form of battery cannot, of course, be generally used on subscribers' instruments.

Many modifications of the Leclanché battery have recently been introduced, some having remarkably low resistance, but they all polarize more quickly than is desirable. I think that if we have not already a modified Leclanché battery that combines low resistance with constant E. M. F., that we will soon have one, and this will be beyond question the telephone battery of the future. I see no reason why a battery of this kind could not be made having an internal resistance of considerably less than .5 ohm and a constant E. M. F. of 1.48 volts. This battery could be put up in a package with nothing but the terminals projecting, and these I may say should be provided with the best possible forms of binding posts. By using nothing but the best material and properly designing the electrodes, polarization could, to a very great extent, be prevented, and by properly proportioning, the compound exhaustion would take place in all the parts at about the same time. Such a battery when set up would give the very best possible results and would require no inspection. When the battery became exhausted no unsatisfactory doctoring would be done by the inspector; he would simply replace a battery by a new one. Until some such battery is generally introduced we may expect about the same percentage of battery troubles as we are now having.

A vote of thanks was given to Mr. Pickernell for his valuable paper and the same ordered to be made a part of the minutes and published.

In answer to a question, Mr. Pickernell said: The batteries I referred to were the old form of Brush, the first form that came out. I should say that the size was five by eight by twelve—something like that. The two cells of storage battery had two plates each, and the resistance was very low indeed. I did not use the batteries after the electromotive force had commenced to drop off appreciably.

Mr. GIFFORD: I noticed Mr. Pickernell in his paper mentioned the fact that he used three Leclanché cells usually with the long distance transmitter. I wish to say that we have several of them in use. I started out rather on my own hook to see how many cells were wanted. I commenced with one, two and three, and I carried it up to four, and on the line on which we have them in use I found that four cells gave the best result. While I do not wish to have the association espouse the interest of any particular battery, I would like to know what battery has been found to be the best for long-distance transmitters. That is a practical question that we can discuss here without reflecting upon any particular battery, I think. As a matter of fact we want to get at the very best battery—what has been found to be the best.

Mr. SEELY: I would like to state to members of the Convention that the Metropolitan Telephone Company, of New York, are putting in a storage battery for their transmitters, especially for the exchange work. We are about to use a cell we call "Type D," giving 7 ampères of current, an internal resistance to about $\frac{6}{1000}$ ohm, and 2 volts. Those batteries are about 7 inches high by 12 inches square.

Mr. LOCKWOOD: I need scarcely say that I for one was much pleased with Mr. Pickernell's paper. I notice, however, one point in Mr. Pickernell's paper which, since it differs from my own experiments, I think it proper to refer to especially. It may be that my experience is a misleading one and that I am wrong on this point. If I recollect right he stated that we were to be careful in the use of Leclanché batteries, not to use too much sal-ammoniac. If by using too much he means that we are not to fill the jars full and then try to moisten it, I agree with him. If, on the other hand, he means that we must be very chary about putting sal-ammoniac in, I cannot agree with him. As a matter of fact I have found in the course of some 13 or 14 years of experience in telephony and otherwise, that the amount which the dealers (especially the Leclanché Battery Company, who are very careful to send out nothing but good material) send out is exactly the amount which it is proper to use, and that we can neither diminish that nor increase it with advantage. It is true that crystals will form upon the zincs and upon the lower part of the carbon, but as long as crystals of sal-ammoniac only fall on the zinc no great harm will come. It is also a fact that when there is little sal-ammoniac in the solution, oxychlorides of zinc and ammonium at once form on the zinc, and these salts, being insoluble, take away just so much of the conducting surface of the zinc, and thus increase the resistance of the battery, besides preventing the necessary consumption of the zinc, which is absolutly essential to the proper working of a battery. I did not notice any other point in the paper that I should care to criticise at all, and it may be that this is simply a difference in definition. I dare say when Mr. Pickernell comes to restate his views they will be found to be not far from those which I have enunciated. I am also very glad to note from what Mr. Seely says that the Metropolitan Company is making an experiment in the way of using secondary cells. I should like, if I may be allowed, to place myself in front of the association for the moment, to request Mr. Seely, what I have no doubt he will gladly do, to make a careful observation of the result of such batteries, so that at our next meeting we may be enabled to know something about it. Of course if we had a storage cell—if we had a secondary battery with just sufficient voltage and furnishiug just sufficient current for our needs—no doubt that would be the ideal cell. If we should use such a cell of course we should be subject to the necessity of recharging; but the Leclanché cell is not wholly free from such disadvantages. The best batteries we have had in our telephone work have to be looked after. In 1882, when I was in Cincinnati on a short visit I found that the Cincinnati service was far ahead of anything that I had ever seen in any exchange before, and when I came to look into the matter I ascribed it more particularly to the constant inspection and the great care exercised by the City and Suburban Telephone Association of Cincinnati in looking after their batteries.

Mr. PICKERNELL: I would state that I quite agree with Mr. Lockwood in respect to his statement about the use of sal-ammoniac. I mention that fact because I found that it was not infrequent for telephone inspectors to put in two of those packages of sal-ammoniac instead of one, thinking that by so doing they might possibly save a trip there in a short time. It is only about two weeks ago that I found three cells of battery which we were using on a long-distance transmitter in which the zincs were entirely covered with crystals of sal-ammoniac. The reason my attention was called to that fact was that the transmitter would not work at all; still there was a circuit; you could get the click all right when you moved the telephone hook.

The PRESIDENT: How many ounces of sal-anmoniac does the Leclanché Company furnish?

Mr. PICKERNELL: I think it is four ounces.

Mr. GIFFORD: It used to be six.

Mr. PICKERNELL: In reply to the gentleman's question about the number of cells to be used with long distance transmitters, we find, if we use low resistance batteries, that three cells are as good as four, there being practically no difference. But if you have batteries in which the resistance is increased from any cause whatever—it may have been of unusually high resistance—you will find that four batteries are better than three. In other words, if you should try to make the experiment by first putting on one battery and talking, and then two and three and four, if you start with a battery having high internal resistance, you will find four will be enough. On the other hand, if you use batteries with low internal resistance, you will find three quite as good as four. Of course, with three the chances of trouble are less than with four.

Mr. GIFFORD: In selecting batteries for our long distance work we are very careful to see that our batteries are as nearly perfect as possible. When the millennium comes I suppose we shall have perfect batteries; not before. I am always very careful to select good batteries, and I have found that in some instances four cells give better results than three, although three have worked very well. One word in regard to sal-ammoniac. That is one of the questions that varies somewhat in different localities. A short, practical rule that I have adopted is to allow an inspector to put in no more sal-ammoniac than you can dissolve in water. I do not leave any at the bottom of the cell at all. I found, as Mr. Lockwood says he found, that they will load up a cell with two or three charges, so that they will not have to go back. I only allow them now to put in as much as you can dissolve. That varies according to the kind of water in different towns. In a town where you use lime water it will not hold so much sal-ammoniac in suspension as pure river or rain water will, and in some places where you happen to have water strongly charged with some mineral it will not dissolve very much. That varies a little. I mention that more as theory than practice. Of course, I do not suppose it will make a varation of half an ounce in practice.

Mr. THORNBERRY: In my experience I rather favor the disposition of the batteries described by the gentleman who last spoke, in placing just enough sal-ammoniac in the battery to keep it doing its work. I want to say, in reference to the long distance telephone, that where hard work is being done the Leclanché battery will hardly answer the purpose, if it is in an exchange where it is used frequently; but a four or six-cell gravity battery will serve the purpose just as well. That is to be determined by the length of the line in which you wish to work it or the condition of the battery itself. The sulphate of copper battery, or gravity battery, has to be constantly at work or it will polarize itself. If it is constantly at work and cleaned once a week, the gravity battery will give splendid results and give you splendid transmission for your long distance telephone. But we determined some years ago, when this telephone first came up, that four cells of the Leclanché battery was the best. The first experiments we made were with the Fuller battery. We used three of those, and that gave us six volts, and the internal resistance was about the same as the Leclanché, and then we used the four Leclanché cells, which gave us in the neighborhood of six volts.

Mr. BAILEY: The point aimed at seems to be to get an effective working battery of low internal resistance. Has any one experimented with the Leclanché batteries on any kind of telephone in multiple? In using them in multiple you would get much lower internal resistance, I should say, and, of course, a greater quantity of current.

Mr. LOCKWOOD: I might say that some two or three years ago the chief clerk of our company, Mr. R. W. Devonshire, sent me two or three transmitters with the instruction—I don't know whether it was directed to me specially, or whether it was in the nature of a circular—which gave me the exact information how much battery I ought to use for the long distance transmitter. I did not follow the instructions with great care, and I tried them with a number of cells of different kinds. I tried them with one, two, three and four cells of Fuller and different bi-chromate combinations. I tried them with one, two, three, four, five and six cells of Leclanché and other similar batteries, and I tried them, as Mr. Bailey has spoken of, three in tandem and two abreast, three in series and two in multiple arc, and I found that while that arrangement was new it worked beautifully. It furnished the proper amount of current, or at least it furnished a very good amount of current, and it worked very nicely. But when that battery grew a little older, I found that it did not work as well, because it was impossible to make the two sides work alike; one side got a little stronger and kept getting a little stronger than the other. Consequently, instead of both points of the current going one way, the stronger battery took a notion to polarize or go against the current of the other side. While it was new it worked very nicely, but after two or three weeks it did not work so well. A better way would be to do, what I am surprised battery manufacturing companies have not done before, *i. e.* to make a larger Leclanché cell. Possibly they have done it before, but it has not got into the market. A demand has come, however, for a Leclanché cell about twice the size of the present cell. I have a Fuller battery under my desk, and it has worked unchanged for eight months. It works pretty well, and you could not tell from the operation whether it was an old battery or that it had not been cleaned for eight or nine months. As there are only two cells, it does not make much gas and does not annoy me at all. But while acid is good in an office like mine or in the headquarters of a telephone company, it is not good for subscribers' stations. So I think that we shall have to put our trust still in the peroxide of manganese battery until we can find that peroxide of lead is as constant as peroxide of manganese, and it is a proper thing, I think, for manufacturers to consider whether they had not better increase the size of them. The point mentioned by Mr. Gifford or some other gentleman, that where the Leclanché Battery Company once provided batteries with six ounces they now only provide four, can be accounted for by the fact that there are several sizes of Leclanché batteries, and they have provided six for the larger size and four for the smaller size, and it is always economy where we are buying for telephone transmitters to buy the larger size.

Mr. SEELY: The present plan of the Metropolitan Company is to make an inspection once every month. The solution is thrown out and a new solution made up. Each inspector is provided with a measure holding four ounces of sal-ammoniac. We guard against overcharging the batteries in that manner. We find that the Gonda porous cup is about as good as the Leclanché battery. Taking the current at the electrodes of the battery we find that we get 1.7 volts with an internal resistance of 1.7 ohms. After using that battery through a resistance of 8 ohms for five minutes we find that the voltage falls to 1.3 volts, the current to .5 ampère and the internal resistance has increased to 2.6 ohms. Short circuiting of the battery for an hour and five minutes we get .3 volt and .3 ampère and 1 ohm internal resistance. That battery was far ahead of any we experimented with.

The convention then adjourned till 2:30 P. M., and remained in executive session until 5 P. M.

SECOND DAY, WEDNESDAY, SEPT. 5.

The meeting was called to order by President Metzger at 10 A.M., and Mr. C. L. McClure read the following paper:

DYNAMO CURRENT INTERFERENCES WITH TELEPHONE SYSTEMS AND MEANS OF RELIEF.

During my earlier telegraphic experience I became imbued with the universally accepted belief in the theory that the earth was an immense reservoir of electricity, and that on that account, and because of its immense mass, it offered no appreciable resistance to the transmission of electrical force. Hence the universal use of the earth as a return conductor for telegraph and other electrical circuits, which are in consequence called "mixed circuits," in contradistinction to circuits composed wholly of metallic conductors. But my attention being called to the behavior of our telegraph apparatus under the influence of extraneous currents, I was finally led to question the correctness of the theory of the "infinite conductivity" of the earth.

Like nearly all of the early workers in the new field opened up by Prof. A. Graham Bell's invention, I was also led into the error of attributing to "induction" nearly all the ills to which the telephone was heir.

Experience and observation, however, soon convinced me that nearly all the telephone troubles popularly supposed to arise from "induction" were the result of "leakage" only; induction operating only at minute distances, while leakage would occur across wide intervals. Hence I was to some extent prepared for my subsequent experiences with the effects of electric light and electric power circuits upon telephone systems, experiences which, as I will now proceed to explain, confirmed me in my disbelief in the theory of "infinite conductivity" and the effects of "dynamic induction."

Some three or four years ago, Richmond was captured by the advance guard of the army of Knights of the Dynamo, to which she is now so largely tributary, and the Schuyler Electric Light Company soon had the city ablaze with arc lights. At first we experienced little or no trouble, but after a time strange noises were heard in our exchange telephones, and as the electric light construction was extended and circuits and arc lights were multiplied, the noises increased until they finally became a din over which it was almost impossible to project the voice. After careful consideration, I suggested certain reversals of dynamo currents, and re-arrangement of the electric light metallic circuits, which were adopted by our electric light friends, greatly to our relief. But on some of our exchange wires, notably those on our Broad street trunk line extending to the extreme western and northwestern limits of the city, the howling of the dynamo currents remained comparatively unabated. After further consideration I became convinced that the principal source of our telephone troubles was a long electric light circuit, which traversed Main street to the western limits of the city, then crossed northward to Broad street, which it followed eastwardly to a point opposite the power house, and thence in a southerly direction to the dynamo, thus making a loop about a mile and a half in length by a quarter mile in width. One side of this loop ran parallel with our Broad street trunk line, almost the entire length, with only the width of the street between them. I was at first inclined to attribute to the usual scapegoat "induction" the interference which we experienced on our Broad street wires, but my attention being about this time directed by some of my linemen to the interesting fact which they had discovered, that even in the dryest weather enough of the dynamo current on this large loop escaped over the insulators and down the poles, to be perceptible to the tongue when applied to a pole four or five feet from the ground, while in rainy weather a very perceptible shock could be felt by applying the hand to a wet pole.

My former opinion regarding "induction" vs. "leakage" and the "infinite conductivity" of the earth were recalled to me with redoubled force, and I soon settled down to the conviction that *leakage* was the force with

which I had to deal. This conviction was strengthened by the well-observed fact that the interferences from the electric light currents were greatly increased during wet weather.

But the famous Richmond Union Passenger Railway, with its street cars propelled by electricity, became a moving, flashing reality in January of the present year, and for a time rendered the telephone business in Richmond decidedly interesting. Unlike the electric light and power systems, the electrical plant of the railway company was not designed or arranged for metallic circuits, but was, and still is, operated by mixed earth and metallic circuits, the currents being carried to the overhead trolley wires by a system of distributing mains, supported upon poles on one side of the street, these mains being connected at frequent intervals with the trolley wire by short lateral wires termed "feeders." As operated in Richmond, the electric railway system requires a double line of poles, one line on each side of the street for the purpose of carrying short non-electric wires which extend across the street between each pair of poles. These are termed "supporting wires" and are designed solely to support the trolley wires at the proper height above the middle of each roadway. These supporting wires and the network of special supporting or curve wires whose office it is to cause the trolley wires to curve parallel with the curves in the road-bed, are supposed to be insulated from the trolley and feed wires and mains, but as we found to our cost, they were not by any means devoid of electrical currents. During the first six weeks after the inauguration of the electric road we had eight sets of telephones and one central office annunciator drop burned out by the railway currents, and about half of these accidents were due to crosses between our telephone wires and the supposed-to-be harmless supporting wires. While these accidents demoralized our linemen and operators to some extent, they fortunately resulted in but little damage to property and none whatever to human life; and but few of our subscribers learning of them, they created no special commotion.

But the effect of the railway system upon our central office apparatus and telephones, from the very inauguration of the railway plant to the present time, has been annoying in the extreme, and exceedingly detrimental to our exchange service. Almost the first revolution of the battery of railway dynamos tripped the annunciators of our magneto lines, and rendered necessary an immediate resort to the use of special armature springs to overcome the magnetism imparted by the currents from the railway wires. Our "testing-off" galvanometers were rendered inoperative, because at first the polarity of the extraneous currents was opposed to that from our galvanometer batteries, and the galvanometer needles were deflected in a direction contrary to the position assumed when under the influence of the batteries alone, the leakage from the railway wires being sufficiently strong to overcome the current from three cells of Law or Leclanché battery.

This trouble I remedied by reversing the poles of my galvanometer batteries so they would, with the exception to be mentioned, coincide in polarity with the extraneous railway currents. And this exception, coupled with the continuous and steady nature of the extraneous currents, confirmed me in my belief that it was leakage and not induction from which we were suffering.

At the power-house or dynamo rooms of the railway company, distant three or four squares from our central office, the battery of five or six dynamos which furnished the current for the car propulsion, was grounded, the negative electrodes being connected to several large sheets of copper at the bottom of a deep well upon the premises, the positive electrodes of the dynamos (coupled up, of course, in multiple arc) being connected "to air," as a telegrapher would put it, or to the distributing mains. From all of our exchange stations located in the vicinity of the dynamo rooms, within the radius of an entire block in fact, we would therefore get a negative leakage current, while from all other stations which were grounded within a square of the railway track and wires, we would obtain a positive current, thus rendering it impossible to arrange our galvanometer batteries to coincide with these leakage currents of opposite polarity.

We cannot therefore to-day use our galvanometers for "testing off" the few stations located in the immediate vicinity of the dynamo rooms. Identically the same effect was produced upon our head-phone test circuits, the railway currents completely neutralizing the currents from our "test" batteries. This difficulty was also remedied by reversing the poles of the batteries.

The exchange lines most greatly affected by the railway currents we found by experience were those which were grounded nearest to the railway tracks, irrespective of the general direction of the wires or their proximity to or distance from the railway, lines that in no place approached within less than a square of the railway wires being as greatly affected as many others that ran parallel with, and in close proximity to the railway wires for long distances, but which terminated and were consequently grounded at points comparatively remote from the railway.

In like manner lines grounded near the heavier grades and curves of the railway where the motor men are compelled to use the maximum amount of power in order to ascend the grades or round the curves with heavily loaded cars, are more seriously affected than lines grounded near the levels. So clearly is this the case that our operators can readily tell from the character of the disturbance which they experience, when a car is ascending a grade, or when it stops or starts.

This effect of the movement of the cars you of course understand is due to the fact that the dynamo currents, when propelling the cars, are short-circuited from the trolley wires through the motor fields and armatures to the earth, thence spreading over every available conductor in their efforts to reach the dynamos. But the maximum disturbance is experienced when three or four cars are following each other in close file, either on a grade or level. In that case the leakage due to each car traverses the contiguous telephone wires simultaneously, producing in our telephones a composite or mixed tone, each motor having its distinctive "timbre" or tone quality, and all united fairly making Rome—or the telephone, rather—howl, and drowning out the puny currents induced by our microphone batteries.

Learning that the railway people were utilizing the municipal gas and water mains in order to reinforce their ground connections, it occurred to me that possibly the fact of our lines being generally grounded on the gas and water pipes had much to do with our troubles. I had some of our wires removed from these systems and connected direct to the earth through made grounds, but without altering the results.

The 450 or 500 volt currents of the railway mixed circuit system do not, however, interfere as greatly with our Richmond exchange service as the 4,000 or 5,000 volt currents carried by the metallic circuits of the electric lighting systems. Did the railway service require currents of the same E. M. F. as the arc lights, the telephone would have to retire from the field,—lose ground in fact,—as metallic circuits would be their only salvation. What the railway currents lack in E. M. F., however, they make up in current strength, and are, therefore, more dangerous to property than the much more intense electric light currents. The latter will melt a fuse or burn out an arrester instantaneously before time is given it to enter a central office or a subscriber's station, and damage the telephone or outfit; while the less rapid but larger quantity of the railway current takes an appreciable time to melt or fuse an arrester, thus permitting it to burn out a hand-phone, an induction coil, or a bell or annunciator magnet, before the protector, of whatever kind it may be, can properly act.

In my experience the greater tension of the electric light currents renders them doubly disastrous to telephone exchange service, the voice being more completely drowned by the intense disturbance due to the electric light escape than it is by the escaping currents from the lower tension dynamos. But the fact of the electric light being in demand, particularly the arc lights, only after business hours, renders the disturbances engendered by them less noticed by subscribers generally than the weaker and less marked disturbances proceeding from the railway generators, which are continuous throughout the entire business hours of the day, when the telephone service is in constant demand. Did the arc light service continue during the hours of daylight as at night, telephone exchanges would be compelled to suspend operations or adopt the only alternative, metallic circuits, with the attendant increase in complication and expense.

Having thus discussed the effects of extraneous electric light and railway currents, let us address ourselves to a brief consideration of the remedies which we have at hand. Anti-induction devices for the elimination or exclusion of extraneous currents from telephone circuits, whether they be artificial or natural, are plentiful, but none have yet been devised that can at all compete with the old-style metallic circuit.

But the metallic telephone exchange system carries with it not only a double expense for construction, maintenance and repairs, but a vast outlay and increased complication and expense for central office plant and service, there being two line wire terminals to provide for every subscriber, and necessarily four terminals to handle for every connection, instead of two, as with the single wire and earth systems.

This great increase in wires, in complication and consequent liability to derangement, and in initial cost, and subsequent expenses for operation and maintenance, almost prohibits the adoption of the ordinary metallic system. None but the wealthy, like our long-distance friends, can afford such a luxury. But there is a metallic circuit system within reach of even the poorest of the American Bell Telephone Company's lessees, a system of my own devising, and which I have found by practical tests to accomplish all that can be desired from an ordinary metallic circuit, and at but a tithe of the expense.

Recurring now to my theory that it was not "induction," but leakage, that annoyed us, and the expression of my disbelief in the infinite conductivity of the earth, it will readily be seen how, after arriving at those conclusions I would very naturally reason thus: If our telephone troubles are due to leakage from the electric light and railways, and this leakage overflows into our wires from the earth *because* the earth offers an appreciable resistance to their passage, why cannot we adopt a metallic conductor of exceedingly low resistance, or of a conductivity approximating that of the earth, and use *it* in place of the earth as our return conductor, making it, in fact, what may be called an "artificial" earth or ground, and at the same time cutting loose from the earth entirely and gaining all the benefits of metallic circuits?

This idea I conceive to be in strict conformity with Ohm's law, and if only the relative resistance of the "artificial ground" or earth and the line wires attached to it were properly adjusted, we would have identically the same results achieved by the usual earth connections and without the disadvantage of the mixed circuits. This thought revolved in my mind for some months before I could find time and opportunity to verify its truth or falsity by experiment. Besides, the device was so simple that I could scarcely conceive that it was possible that it had not already been tried and found to be impracticable by some member of the army of electricians that had been so long engaged in efforts to solve the anti-induction problem; and it was only after conferring with some of my brother telephonists, who were favorably impressed with the idea, which was novel to them, that I took the time necessary for experiment. I, however, finally connected up several telephone circuits with a common return wire of low resistance, and found that conversations could be carried on, and a magneto call bell rung on each circuit without any mutual interference whatever, and it required a resistance of 35 ohms by galvanometer measurement to be added to the common return wire before the currents propagated in one circuit could be heard in the telephones on the other circuits. I thus concluded that there was approximately 350 ohms resistance in each circuit, due to the conducting wire, the call-bell magnets and the hand-phones and transmitters, and that the "artificial ground" wire should bear to the other side of each circuit, the direct or line wire, a resistance approximating one-tenth that of the entire circuit.

Encouraged by this experiment and anxious to do something to improve the night service of my exchange, I laid my scheme before the executive officers of my company, and was furnished with a half mile of No. 4 copper wire with which to make some practical tests. My first experiment was with our No. 19 northern call wire and its connecting lines. This was our shortest call wire, being only a third of a mile in length, and had connected with it some 18 or 20 subscribers' stations, located in close proximity to the Seventh street grade of the electric railway, an 8 or 10 per cent. grade, extending from Franklin to Grace street, one square. At the corner of Seventh and Franklin streets, the main feeder wires of the railway plant direct from the power house, two squares distant, first touched the line of the railway and divided right and left to the opposite and distant ends of the road. At this point, as might have been anticipated, on our telephone lines grounded in this vicinity we experienced the greatest interference, particularly when a heavily loaded car was ascending the hill. My "artificial ground" gave us immediate and remarkable relief from the railway leakage, and without any cross talk whatever. I then applied a half mile of No. 6 covered copper wire, which I connected to the end of the first half mile of No. 4 wire, and extended the artificial ground wire on out to the western end of the city, intending to make my next test with one of our longest taps and our longest lines, with stations located near the most westerly extension of the long Main and Broad street electric light loop of which I have already spoken. These lines had been almost entirely abandoned at night, our subscribers averring that they could not use their telephones at all after the electric lights were ablaze.

The worst of all was a station in a drug store, whose proprietor had long made bitter complaint that his telephones were of no service to him after dark. Yet when the change was made from the natural to the artificial ground at this and all other stations on that call-wire tap, the relief from the electric light leakage was as instantaneous and marked as that experienced from the railway leakage on short tap No. 19. In fact such was the change wrought on these wires that it was possible to carry on a whispered conversation over lines connected to my artificial ground, that when connected to the natural earth were so noisy that even the loudest shouting could be heard only with extreme difficulty.

While cogitating over my idea in its incipiency it occurred to me that even the adoption of a *general ground wire* of high conductivity would relieve our telephone wires from the influence of these extraneous currents to a great extent. This I found from experience to be true.

When arranging for the central office end of my "artificial ground," I had made a plug switch so arranged that by the insertion or removal of a single plug I could connect the artificial ground wire to earth, or disconnect it entirely from the earth, and with one motion connect it with all of its attached wires into a "compound metallic circuit system." I could thus readily note the difference made by the use of the large copper wire as a *general ground wire*, or as a substitute for the earth. In the one case, as you understand, if I have made the matter clear to you, the large copper wire was connected to earth at only one point through the plug switch in the central office, while in the other it was disconnected from the earth entirely.

To those familiar with the details of a telephone exchange, it will be clear that some such provision for grounding or connecting artificial grounds to earth is essential, as long as any of the wires of the system remain in connection therewith, because of the necessity of connecting stations not yet changed to the artificial ground to those that have been thus changed; otherwise the one will be grounded and the other "dead open," and, consequently, inoperative. In this way I found by experiment that, when the large copper conductor was to earth at the central office and was being used simply as a general ground wire, the electric light and street railway interferences were reduced about 50 per cent., and when used wholly detached from, and wholly in place of, the earth, they were reduced the other 50 per cent., or eliminated entirely.

By thus utilizing the large conductor, *first*, as a general ground wire to carry the michrophone and signaling currents to the earth at the central office, or at any other locality remote from the offending electric light or railway plant, an exchange system can be gradually converted from a mixed metal and earth system into a compound metallic circuit system throughout, without any interference whatever with the service of the exchange, and to its manifest improvement during the time the change is being made. And when the last subscriber's line has been transferred from the natural to the artificial earth at the last station, it is only necessary to withdraw the solitary plug that still connects the system to the earth, and, presto! you have an exchange of purely and practically metallic circuits alone, with all of the advantages of the ordinary metallic circuit systems, the one series of large copper wires extending out on the various trunk lines, but all united in one at the central office, answering fully the purposes gained by the ordinary duplication of each individual wire, and necessitating no change whatever in either central office or station outfits or appliances, beyond the simple substitution of the artificial for the natural ground.

In practice it may be found that a greater proportion than one-tenth the resistance of any one circuit may safely be given to the artificial ground wire, but my experience and experiments lead me to believe that it will be far safer and more satisfactory to keep the resistance of the artificial ground to one-twenieth that of the entire circuit.

In an exchange the size of our Richmond exchange I advocate the use for each individual trunk route of a single copper conductor composed of a half mile each of No. 4 and No. 6 wire with No. 8 for lateral lines and the remaining distance to the farthest stations, with No. 14 to stretch from the poles into the stations. All of these wires should be of hard drawn copper with a good covering, and strung on the same poles and fixtures that carry the regular exchange wires, but insulated carefully both from them and the earth. And I should place these artificial ground wires at the lowest point on the poles, or the least distance from the sidewalk or ground, beneath all of the line wires if possible.

In this position the small amount of leakage currents that are attracted up the poles from the earth, whether from electric light, electric railway and power circuits, or earth currents, will be intercepted by the large copper wires, and by them carried to those points in the system where they will escape to earth again without any adverse influence upon telephone wires proper.

While in the absence of any direct experiments I cannot say positively that such will be the case, I believe, however, that if our long-distance friends will couple together so as to make of some eight or ten of their No. 12 or 14 copper wires practically a single low resistance conductor, they will find that this compound conductor will answer as an artificial earth or return wire for treble or quadruple the number of wires thus coupled together, while a single conductor of the same conductivity would double the capacity of their poles and the number of their metallic circuits. In like manner, I believe the same principle can be applied to telegraph and electric light or power circuits, relieving them from the disturbing

and damaging influences of earth currents and atmospheric electricity, and conferring upon them all the advantages of metallic circuits without the ordinary duplication of wires.

In conclusion, allow me to say that, while I flatter myself that I am charitably disposed and ever inclined to do all that within me lies to further the interests of the telephonic fraternity and increase the efficiency and value of our telephone service. I do not think I am justified in assuming the role of public benefactor and giving my device away, even in the interests of science. Believing it to be novel, practicable and valuable, I have therefore conceived it to be my duty as well as privilege to apply for a patent, and my application is now pending, with, I trust, a good chance for a favorable decision.

Mr. LOCKWOOD: I would like to ask Mr. McClure whether he has made a point of having his return conductor parallel with his main lines.

Mr. MCCLURE: Of course, in every instance. I have only, so far, in the Richmond Exchange provided one common return wire; that is, up Ninth and Broad streets, and up Broad street to the western extremity, with branches radiating along the lateral wires. Of course this wire is carried on the same pole and parallel to all the wires connected to it.

Mr. LOCKWOOD: Mr. McClure is quite right, I think, in attributing a certain amount, at least, of the disturbances, and perhaps nearly all the disturbance, occurring from the electric railway to absolute leakage of the electricity from the rails to the telephone wires; but like nearly every person who has at one time adopted one theory for certain phenomena, and at another time another theory, I think he has become an extremist, and, as is usual, the mean is the correct view. A great deal of our disturbance on telephone lines is still due to the old enemy—induction, and although the telephone business is eleven years old now, induction is still just as strong as it ever was. The trouble that electric lighting, and especially arc lighting, has given to telephone men are of twofold character; first, of the character which disturbs the conversation; and, secondly, of the character which destroys the wires and apparatus. Within the last year or two we have become apprised of another enemy in the lighting camp, namely, the alternating current used for incandescent lighting, and these are used not only through converters but also on direct circuits. The telephone line which runs from the Malden Central Office, in Boston, to my own house is a very much disturbed line indeed, and I allow it to remain there so that I can study the phenomena. But we formerly had a Thomson-Houston direct arc lighting machine, with a three-plate commutator, and the noise was bad then; but lately they have taken to lighting Melrose, where I live, with incandescent lamps placed in a direct circuit and operated with an alternating machine, and the noise is now tremendous, because the alternations are almost as quick as the telephone alternations, namely, about 200 per second.

The following paper was then read by Mr. T. D. Lockwood:

ON THE ELECTRICAL RELATIONS OF TELEPHONE AND ELECTRIC LIGHT AND POWER CIRCUITS AND RAILWAYS.

This paper deals altogether with the disturbing effects of electric light and power currents upon telephone lines, and not at all with the dangers of imperfect construction and insulation; nor with the results and prevention of dynamo current crosses, there being sufficient in the latter branches of the subject for a separate and equally voluminous paper. It will consequently be assumed for the purposes of this paper that the important precaution of effectively insulating wires conducing heavy currents is observed, and that "undertakers' wire" is, as it ought to be, a thing of the past.

The telephone exchange business was commercially organized and established in the first months of 1878. Electric lighting as a commercial industry had its beginnings in 1878 and 1879, but did not at first take root with the same degree of rapidity which characterized the exploitation of the telephone, and not until some years thereafter did it achieve popularity.

Consequently the telephone systems obtained considerable start, and were firmly established in nearly every city and town in the country before the organization of many electric lighting systems. It was not at the outset generally known that the telephone circuits would be annoyed by the presence and proximity of parallel electric light wires; and telephone companies were thus at first most liberal in permitting the erection near their lines of foreign lines carrying heavy and widely fluctuating currents. Yes a little thought and consideration would have laid bare this danger. We knew that the telephone current was itself of most shadowy and almost intangible character in point of strength, and that to utilize it, such a supersensitive instrument as we all know the telephone to be was actually essential. And we knew that *because* the telephone receiver was such a delicate electroscope, and so sensitive to electric motion, we had heretofore been much annoyed by mutual telephone induction, by telegraphic induction, and by miscellaneous induction. So, as I say, if we had carefully considered the matter, we might have foreseen the full extent of the electric light disturbance which is now being sustained.

But we did not foresee, and as a result of our lack of foresight indiscriminate construction has ensued; and in consequence of improper construction the business of many telephone companies has at certain points been directly or indirectly injured by the presence and operation of electric light wires, and an appeal to the courts has been rendered necessary.

Until within a comparatively recent period the disturbance resulting from dynamo current induction was, with an occasional and rare exception, limited to certain evening hours, and to the night, because during such portions only of the day were the lighting circuits in operation. But of late, in many places, the wires used in the night for lighting are also used during the hours of daylight for transmitting power from the dynamo to large numbers of motors which may be widely distributed; and as this utilization is certain to have in the near future an enormous expansion, we are compelled to face the prospect that even during the hours of business, telephone wires are now liable to severe disturbances. Therefore it seems time to call a halt; we could be patient so long as we were only called upon to suffer from the "pestilence that walketh in darkness," but when we are also threatened with "the destruction that wasteth at noonday," it behooves us to have something to say about it. Super-added to the above causes, we now find that electric railways are being introduced in rapid succession, and we find to our cost that many of them are much more active than are electric lighting circuits in setting up disturbing currents in telephone lines; the disturbing current from electric railways being frequently sufficiently strong to vitalize the annunciator magnets of a telephone central station, and to actuate the drops.

Now, I have no quarrel with electric light and electric railway companies, considered as such. No man rejoices more heartily than I in the triumphs of electricity and in the tremendous spread of its usefulness. I recognize fully, moreover, that the lighting, power and transit utilizations of this mighty form of energy are fully as useful as is its function in carrying intelligence; and that these utilizations have properly become permanent institutions, and, equally with our own, public conveniences. Nevertheless we were first in the field, and although we may admire both the energy of the electric lighting current and the energy of its introducers, we must in our own defense be prepared to take the position that no newcomer has a right to construct his plant in such a way that an established business shall thereby be ruined or impaired, and that if it be absolutely necessary to erect electric light lines in proximity to telephone lines, the construction must be of such a character as not to involve detriment to the pre-existing telephone lines.

Can electric light and power lines be constructed so as to be near telephone lines without interfering with them? Certainly they can. Consider how the disturbing currents originate: First, most arc lighting circuits can set up considerable induction on telephone lines. Second, alternating currents in main wires, whether used for arc or incandescent lighting, are intensely provocative of induction and noise in telephone circuits, the character of the disturbance being much worse than that which is produced by lighting currents of constant direction, this latter sounding in the telephones like a protracted musical note of great volume. In speaking of the above it will be understood that the detrimental action upon telephones is the same when the dynamo current is used for motors as it is when used for lighting. Third, certain classes of electric railways very seriously interfere with the operation of telephone lines, both in conversation and also by establishing thereon a current which permanently excites the annunciator magnets. The noises which are produced in telephones by dynamo current induction are so well known that it would be waste of time to describe them.

When the troublesome currents are produced by electric light or motor circuits they may usually be attributed to induction, although a certain amount of absolute leakage doubtless also exists. Since, however, both causes produce in telephone circuits a like effect, it will be sufficient to speak of induction only. But if we consider the action of electric railways upon telephone lines, we find that the major part of the disturbance is due to the actual transferrence of a portion of the electricity which actuates the train motor to the telephone lines, by way of the rails (when these are used as return conductors), the crust of the earth itself, and the telephone line terminal ground wires.

As most of us know, the alternating current has received lately an increasing amount of the patronage of our light-producing friends; and at the present time both constant direction and alternating currents are largely used in electric lighting and power distribution circuits, the intensity of the disturbance varying with the class of current employed.

The violence of the induction, and therefore of the disturbance, depends upon the proximity and longitudinal distance of parallelism of the disturbing wire, the strength of the inducing current, the frequency or rate of change per time unit of the inducing currents, and the extent or range of such change. That which is due to wires carrying alternating currents is, of course, much stronger than even the worst case of direct current induction, for even though the distance of exposure and the strength of the inducing currents be identical, it is self-evident that a current which is completely reversed a great number of times per second must be much more energetic as a disturber of the peace than one which is constant in direction, and which varies only in strength on one side of the zero line. These considerations indicate that our methods of prevention or cure should be directed at the stronger disturbing agency, since such a degree of success as we may be able to achieve against that will necessarily be equally effective as regards the weaker.

The proper way to cure or neutralize electric light or power induction *is to prevent it*. It is quite within the bounds of good construction so to relatively arrange lighting and telephone circuits that no disturbance will result, and it is obviously much easier and less costly to construct them properly in the first place than it is to change them. To secure this most desirable result, viz., the harmonious co-existence of these widely differing classes of electric service, I wish to point out that co-operation between the parties concerned is absolutely essential, together with a clear and full understanding of the conditions involved. Yet in too many instances, though, as I have stated, where the telephone wires were already in the occupancy of the field, telephone companies have negligently omitted to watch their own interests with sufficient care, and have, without remonstrance, permitted electric light companies to erect wires close to their own, and of such a character as to render inductive disturbance a foregone conclusion. Would not a general good understanding between the different electrical interests of any city or town be desirable for the forestalling of such chances of future disagreement? Informal discussion, amicable conference and mutual consideration between the authorities of the several interests would tend to preclude any possible future misunderstanding, and would certainly act to prevent unnecessary antagonisms either between any of the several individual interests or with municipal authorities. A good understanding all round is therefore suggested, as being an admirable forerunner to a system of non-conflicting construction.

Local managers of telephone companies should be instructed to report to headquarters at once, the intended construction of either electric light or railway circuits at any point within their territory, so that proper measures can be concerted, and adopted to meet the special conditions of the case. If the general satisfactory understanding, which I have outlined, can be reached, it should not, I conceive, be difficult to bring intending electric light and railway officials to see that construction which is innocuous to their neighbors, and which, in virtue of the provisions necessary to secure such innocuousness is thereby made safer in all respects, is (all things considered) both cheaper and better than construction which is at any time liable to involve them in trouble, misunderstanding and damages.

The element of distance is of the highest importance. Telephone and electric light wires cannot be too far separated for the efficient working of the former; and the wires last strung should be run, if possible, on the other streets from those in which wires are already in operation. In no case ought the two classes of circuits to be nearer together than the width of an average street. In writing the above, I have not forgotten that it is oftentimes a matter of mutual convenience, that reciprocal privileges should be allowed. This idea is by no means in conflict with the general principle that distance is the most efficient neutralizer.

The good feeling and understanding which I have advocated will be productive of a tendency to keep down unnecessary pole construction, and if either interest have a pole line through a certain territory, and if the other party have but a few wires going in that direction, it is doubtless often the best policy and practice to make the existing pole line available for both. By suitable agreement on this head, both telephone and electric light systems are enabled to use each other's poles on occasion, and thus to carry a sporadic line, and accommodate a customer in districts which could not otherwise be reached, at least with due regard to economy. It is, of course, understood that an electric light company thus stringing wires on the poles of a telephone company must properly run its wires so as to produce at most a minimum disturbance, and that a telephone company taking its chance on electric light poles must not expect first-class results, unless it be returned through the region of disturbance. The responsibility in the latter case is on the owner of the telephone wire alone.

If both sides of the street be fully occupied, and it should be really necessary to carry a main route of wires of both systems on the same side of any street, no other street being available (a state of affairs which ought not often to exist), it would, I should say, be better for them to be upon a single line of large poles than for each company to provide its own poles, and thus to incur the enmity of abutters, property holders, municipal authorities and iconoclasts generally, for a uniform style of construction can then be adopted, and as the telephone current is the weaker, the telephone poles should carry both sets of wires, and the construction should be supervised by its officials. This procedure is, however, only admissible if no other route can be found for the wires of that concern arriving last on the ground; and I repeat that wherever circumstances will permit, the width of an ordinary street at least should intervene between the wires of the two systems.

Electric light and power circuits ought always to be metallic, and in fact every self-respecting electric light circuit *is* metallic; this, however, being altogether without regard to its relations with contiguous circuits of other classes. But a lighting or power circuit which is contiguous to telephone circuits must not only respect itself, but must respect the telephone circuits also, and hence must not only be a metallic circuit, but must have its two wires parallel and as close together as possible, so as to be practically equidistant from the telephone wires; this, in order that the inductive effect exercised by the outgoing and incoming wires may be equal and opposite.

Where the distance of the width of the street is observed the parallel return wire frequently provides all the necessary neutralization, and prevents disturbances, for the neutralization is necessarily more perfectly effected as the distance of the two wires of the electric light circuit from the telephone wires is increased, because the distance of the two wires of the lighting circuit from one another is a much less factor in a greater distance, such as the width of a street, and the two wires therefore operate much less independently than is the case when each wire is almost as near to a group of telephone wires as it is to its own mate. It is, however, often found (and especially when the two sets of wires are on different horizontal planes of the same poles) that even though the two wires of the lighting circuit be substantially equidistant from the telephone wires, perfect neutrality and noiselessness is not secured; and the degree of remaining disturbance is greater or less according to the distance between the wires of the two systems and the distance that the said two sets run in parallel contiguity. This remaining disturbance manifests itself because the electric light circuit is not balanced. If, for example, one of the two sides of a lighting circuit be made to serve one or more lateral loops, while the other runs straight, or if one be connected with a greater number of lamps than the other, there is no balance; the electrical centre of the main line does not coincide with the mechanical centre, and one of the two wires exercises a much greater inductive influence than the other, the result being noise. By arranging the electric light circuit so that each side shall have an equal number of loops of like length, and an equal number of lamps or motors, and then by transposing or crossing the two wires of the lighting circuit about every fourth or fifth pole the disturbance may be totally suppressed.

Such care in construction will most naturally be objected to by electric light and similar companies on the plea of expense, especially by such as have already constructed their lines in a style regardless of the rights of others; yet only by an in insistance upon such conditions, when the two systems of lines are in close proximity, can the business of telephone companies be protected.

It may also be objected that since the parallel return wire cross connected at intervals with the outgoing wire is a remedy for inductive disturbances, it is one which should be applied by the telephone companies, and to the telephone circuits, as being the complaining party. But as to this, in addition to the already stated fact, that in nearly every case where the pernicious effects of induction are experienced, the telephone company was already in business and its wires in place, and that the disturbance originated with the advent of the electric light wires, and that common justice requires that the aggressor should apply the remedy, it may with reason be rejoined that the number of the electric light wires is much less than that of the disturbed telephone wires, and therefore the remedy may be applied to the former with much greater ease and at much less expense.

We have considered the prevention or remedial measures which are applicable to this evil, and it seems clear that the right time for suggesting the propriety of observing these conditions of neutral construction is before the work has been done; and it is probable that the owners of

disturbing wires will be much more willing to heed them, in originally arranging their wires, than where subsequent alteration is required; especially as in original construction the plans suggested would not necessitate the numerous joints inseparable from later transpositions.

In any case, whether such remonstrance or suggestions as may be offered tending to harmless construction be properly received and acted upon or not, it is our duty to offer them, and so to place ourselves in the right, and in the unmistakable position of having at least done our part in objecting to *improper*, and in stating our convictions of what constitutes *proper* construction.

I have already attended to electric railways and to the fact that the weight of the evidence in regard to disturbances developed by them upon telephone lines tends to show that these are due not to induction, but to actual conduction of electricity from the railway conductors to the telephone lines.

There are several classes of electric railway.

1. Those which utilize the rails for both outgoing and return conductors. 2. Those which employ a single overhead conductor, using the rails as a ground terminal or return. 3. Those in which the two main conductors are both in a conduit, to which access is had through a slit, in the same way as a mechanical cable road is operated, trailing brushes or springs being led through the slit. 4 Railways which carry their own electrical energy in the form of secondary battery cells. 5. Railways which employ two overhead conductors, one as the outgoing and the other as the incoming line.

Of these plans the first and second are very detrimental to the satisfactory operation of telephone lines; the fourth is perfectly harmless in all respects, and the third and fifth usually are also, and may be readily so made when they are not; all that is necessary to that end is to exercise such care in construction as to insure that the main conductors are properly insulated, and in the case of the fifth plan, that the main conductors are also prevented from coming into contact with overhanging branches of trees.

A great number of electric railways are built upon the second plan, and where they are run near telephone wires invariably exert a pernicious influence thereon, which is largely due to the imperfect return or earth terminals furnished by the rails; a portion of the current passing from them through the earth to the telephone circuits by way of the sub-station ground wires, thus occasioning interference with conversation and affecting call signal apparatus, and often damaging property.

This class of construction is manifestly improper, both on the score of interference with the telephone wires, and as being dangerous, and is of the cheap and reckless order.

When the remedies for its evils are so simple, and consist merely in adding a second overhead conductor, and in looking well after insulation, it would seem that they should be promptly and universally supplied by reason of the greater security they afford, even though those owning railways may have no just regard for the rights of others.

Telephone companies should therefore exert themselves and their influence in favor of the double overhead wire and other safe form of railway, the former being in fact safer in other respects and more economical in operation than railways which in any way utilize the rails as conductors.

Where other systems are already in use, and should it be found impossible or impracticable to persuade the railway company to provide a return wire, and where the telephone service is consequently impaired, the only absolute remedy is that of providing the telephone circuits which are affected with a parallel return wire.

The disturbances may, however, be greatly softened down or subdued by carrying the ground end of the subscriber's wire from his office or house to some point at a considerable distance at one side, or the other, of the railway and by there terminating it, instead of at the substation itself. Considerable success has also been attained in practice in the amelioration of this trouble by connecting the leading-out wires of a number of neighboring disturbed telephone lines with a large common return wire grounded at or near the central station, instead of grounding each in the ordinary way.

If the leak is so great as to affect the annunciators, it is sometimes requisite that the common return wire, instead of being grounded, shall be connected with the several central office terminals of its group of lines, exactly in the same way that its outer end is united to the outer ends of the individual lines; that is, of course, when these are at rest. By adopting this plan the earth connection is, when the lines are not in operation, completely cut off. If the disturbance does not affect the talking, ground connections can be provided for use during talking. If it does, then the return must be retained during talking also.

Though this paper is already long, there are still one or two points on which I should touch. In one of the children's hymns composed by the late lamented Dr. Watts occur these lines:

> "One sickly sheep infects the flock,
> And poisons all the rest."

And upon the principle thus enunciated, it not infrequently happens that though but few telephone wires, or even but a single wire, be exposed to disturbance originating in and by the causes recited, the trouble is propagated to others by induction by reason of the close massing of large numbers of wires at or in the vicinity of central stations.

Consequently, one wire adversely affected by electric light or railway disturbance may influence deleteriously many others.

The lessons we have to learn from this are that if we have *one* wire so effected, we ought in some way to promptly attack the evil in that one wire, remedying the trouble while it is small and controllable; and that it is essentially our duty to remove dead or unused wires at once, unless there is good reason to anticipate an early resumption of use; and even then they should be disconnected from the two terminal stations; and when I say disconnected, I don't mean simply short circuited, or cut out, but absolutely detached; dead wires being one of the most prolific and active agencies of disturbance and danger. True it costs something to take down wires, and it may be troublesome to put them up again when required, but it is the only safe proceeding, and in such matters the anchor ought to be cast to windward every time. It is better to spend a few cents in defense, than it is to spend possible millions on account of the misdoings of a dead wire in tribute.

Finally, if the number of disturbed wires be smaller than that of those causing the disturbance, or if it be necessary to run a telephone wire through a region of disturbance, the simplest, easiest and most economical way is not to monkey with the buzz-saw, but at once to make the telephone circuit metallic, at least through the region of disturbance, which operation should, moreover, be invariably performed in cases where less drastic measures fail.

Mr. LOCKWOOD: Now one word as to Mr. McClure's device. It is true, as I said before, that the evil he has had to encounter is actual leakage from the rails, and that it has manifested itself both by affecting the coil apparatus and by affecting the conversation, and there was no reason even before he tried his device to doubt that it would do its work. I do not know whether it has totally eliminated the noise, but if it softened it down fifty per cent., as he says, if it has made it bearable so that people can talk, a great deal has been done. There have been since the beginning of the telephone business I think some six hundred patents issued for different forms of telephone, and I think perhaps from three to four thousand patents for telephone appliances, out of which perhaps two hundred have directly or indirectly referred to systems or arrangements or pieces of apparatus for reducing, eliminating or neutralizing induction. A great many are not worth the paper they are written on. But this device of a return circuit I think probably was first indicated by the old way in which those of us who were telegraph men used to run what we called combination locals. We used to have a number or combination of local battery cells, one for each sounder, and we would bring them all back over a common wire. A little later, when the telephone business began, quite a number of people, myself among others, patented a system in which a common return wire was provided for a group of circuits. That was in 1880. In the application for a patent that I put in we had a narrow escape from an interference with some of Mr. Scribner's applications for patents which afterwards went into force, throughout Indiana, Ohio and Illinois as the Wiley-Scribner Telephone Exchange system. I know Mr. Durant remembered it, because he has been in interference with him. Since then the very idea of using a common return as an induction neutralizer has been patented by a man named Bentley, and within the last six months the American Bell Telephone Company bought that patent with a lot of others, and the American Bell Telephone Company buys patents so that its licensees can use them. I have not made these observations with the idea of belittling Mr. McClure's invention, because there is not the slightest doubt that he invented it independently and for his own work; but simply to say that none of the rest of you, if you wish to use it, need hesitate for fear of trenching on his prerogatives, because it is open to every one of you who are licensees of the Bell Telephone Company.

Mr. DURANT: I would say that we have for three years used that device and have it in use now. I think it is applied on twenty-four wires. It came into use from the interference of the Heisler incandescent system, which uses an alternating current. Presuming, of course, that the Heisler circuits were constructed in conformity with the rules of the Board of Public Improvements, namely, in close parallel lines, we did not examine them, and we put this common return wire in use, and we found it very effective. In the meantime we found that Mr. Heisler had one side of his circuit on the side of this street where this particular run of wires was, and the other on the other side. We made him correct that. I was surprised to hear Mr. McClure say it was novel, but as Mr. Lockwood has already intimated, we are not afraid of it.

Mr. BAILEY also spoke of the benefits derived from the use of a general return wire, and continued: There is another point I want to call your attention to—that matter of danger of dead wires in relation to lightning trouble. We have had a little of it out in our country. Of course, we have a system that covers a good deal of country, and is made up largely of country lines, and in the changes in telephone business dead wires occur with us, as they do with every one else, and dead wires are sometimes a good deal more costly than living ones. The usual course of proceeding when a telephone is discontinued is to take the telephone out without making any provision for the wires which are left standing. The question is. During a thunderstorm what will become of a current that may gather on that wire without any connection to the earth? It certainly has to discharge somewhere, and in discharging it is likely to do a good deal of damage. It strikes me that it is similar to the case of a defective lightning rod—a lightning rod which has no earth connection. We have a case of that kind where a loop was taken out on one of our lines. The line got charged from a thunderstorm and the lightning followed in on those open wires and struck a child and knocked it insensible. It recovered without any apparent damage, but it was a thing that it strikes me should be guarded against. Wires of that kind should be removed from the premises.

Mr. FARNHAM: Mr. McClure suggested a plan, or at least he suggested a fact that might exist, which I thought might be misunderstood and might be misleading. He said that in a large place where there were several electric light wires running that one might offset, in a certain sense, the induction from another wire, and so the difficulty need not be as serious as it would be where there was only one circuit. I have found in several cases, in looking up these same troubles, that the electric light people have taken that ground and have said that their system was all right, because notwithstanding the fact that each circuit was a belt circuit, yet the several belt circuits were on the same pole with what they call the positive pole of the machine, and that consequently the interference of one line would be neutralized by the interference of an entirely separate circuit. Of course we will find, if we try it, that this is altogether false, because we cannot have two machines running at precisely the same speed and the changes of current coming together at precisely the same moment of time, and while there may be, in listening at a telephone, a moment when the noise is less, the next moment it will be very severe. One of the noisiest exchanges that we have is where the circuits run in belts on the same poles and yet there is no balance whatever. I speak of that because unless we understand it thoroughly and are ready to answer the electric light people's question in that matter, we may get ourselves into trouble. The only way to remedy that is to take two of those circuits and make a metallic circuit, if there happen to be four or six circuits, taking the same general route, of course that can be arranged so that there will be a metallic circuit of each individual circuit on the same poles without materially increasing the obstruction. In speaking of the electric railways, nothing was said, I think, in the paper or in the remarks about the feed wire. Sprague's system uses a feed wire. I do not know about the Richmond system, but I do know one system in New England where this feed wire is also a bare wire. It certainly is bad enough to use a bare trolley wire with a grounded circuit, but where the excuse is for using a bare wire in places where our wires are liable to touch them at any time I cannot conceive.

Dr. VANDER WEYDE: I am in a position to mention certain results in regard to that general return wire which I obtained in a series of experiments that I made some years ago, with the purpose of economizing the wires with a double metallic circuit, and having one general return wire. I found that if a general return wire, substituted for a ground wire, is not close to the direct wire, it is of no use. I found that it is only reliable when the wires are all connected together as much as possible in a cable. Therefore I adopted the system of making as much as possible a well insulated return wire of low resistance in the centre.

Mr. SEELY: I would like to state our experience with a common return wire for subscribers. In New York City, in 1885, we put up a Patterson cable. In those days they made a cable with a large centre core. I think it was a No. 6 wire. We connected to that cable some five hundred subscribers. We grounded that central core in the central office. While that cable worked fairly well and cut down the induction and cross talk and leakage, we discovered by ringing up a subscriber on a long wire that we would also ring up a subscriber on a short wire, and that with two wires of the same comparative resistance, if two subscribers would attempt to talk at the same time, the cross talk between those two relative wires would be very severe. We immediately abandoned the scheme and considered it useless. I would also like to state, while I am here before the convention, that I presume in New York City we have a larger number of electric light wires in the air than are in any other city in the world. All systems are represented here. It is the policy of the Metropolitan Company to grant pole privileges to those companies. We have a blank form on which they make application to the company, and by so granting them permission to erect their wires on the property of the Metropolitan Company we are in a position to dictate to them; we tell them exactly how we desire their wires to be constructed; how many lamps on each circuit; whether we should divide the lamps in positive and negative sets. The East River Electric Light Company have about 2,200 or 2,500 attachments on our poles, and their wires are built in the most excellent manner. We are suffering very little from the leakage from their currents. They use the Thomson-Houston system and are giving us no trouble whatever.

Mr. THORNBERRY: It seems to me that, providing this return wire is almost as expensive as it would be to the electric light company if they returned their wire, which in equity and justice they should do, it does not seem to me that the telephone companies should establish a precedent which the electric light companies may force them to follow afterward. It is not anything but right that they should put their systems in such a condition as not to interfere with your service. If you are on the ground first you have vested rights. I think the convention ought to take some action in coöperation with the National Electric Light Association. I was almost ready to make a proposal that this association appoint a committee who might meet a committee from the National Electric Light Association to discuss the matter of providing methods and means whereby we might harmonize the interests of the two associations.

Mr. LOCKWOOD: With reference to the suggestion offered by Mr. Thornberry that it would be a happy thing for a committee of this association to confer with the National Electric Light Association, I do not think any gentleman here could listen to such a proposition seriously discussed. We cannot deal with an association in these matters. We have got to deal with individual companies and individuals themselves. An association—even this association—has no authority from any one of its members, though we are bound together by common interests and common ties, much less can another one with several major conflicting interests and several hundred minor conflicting interests behind its members. It would be at this time a thoroughly useless and futile thing to do.

Mr. MCCLURE: If the members of the association will allow me, I would like to occupy a few moment of their time in making a little plainer, probably, than I did in my paper, one or two points that have been brought up since the discussion began. In the first place, with reference to the metallic circuit and the common return wire; as a matter of course, I have known for years that the metallic circuits and common return wires have been in use. I did not suppose that I was originating anything new in devising a simple metallic circuit or a simple return wire. But I do believe that I did devise something new when I devised what I call a compound metallic circuit—a metallic circuit with one wire only to serve the purpose of a return wire with an unlimited number of wires attached to it. I also believe that I have devised a new idea in substituting a metallic conductor in place of the earth without any earth conduction at all. I am perfectly familiar with Mr. Bentley's and Mr. Marbury's patents. They are both for anti-induction cables, and to apply these systems to telephone exchange plants would necessitate the entire reconstruction of the plants. The system that I propose to use does not require anything of the kind—not a solitary wire on poles or house-top fixtures has to be changed or altered in any way; all that has to be done is to put up one additional wire for every wire—I do not care what the number is, one, or two, or a dozen, or hundreds of wires—on the same route, and the only change that has to be made in the system is the simple substitution of this common return wire for the ground. To prove that, I will state that I have in the Richmond Telephone Exchange to-day eighty-seven stations connected on to a single return conductor. That conductor starts from the central office with a No. 4 covered copper wire extended to a distance of half a mile from the central office. Connected to that is half a mile of No. 6 covered copper wire, and continuing the wire runs a mile from the office; beyond that it is my intention to use a No. 8 copper wire to reach the

various stations of the subscribers. I have now one such wire only in use in Richmond, extending from my central office up Ninth street to Broad, and thence out from Broad to the terminus. On that wire I have eighty-seven stations connected just exactly as they were before, to the earth and by means of a plug switch which I have in the central office I can use that common return wire either as a general ground wire, making all these subscribers' wires take earth at the central office, or, by removing this plug, I can disconnect them entirely from earth and use them as metallic circuits. Of course I could not conceive it possible that no one had tried this arrangement before; it was so simple in itself. It was only after making the experiment I did, that I induced our officers to allow me to make this practical test. When I made my first practical test and connected my first ten or twenty stations on the first half mile of copper wire, I was exceedingly interested in how the result would be. The very next night after it was done I went to the central office. I spent nearly two hours, from ten to twelve o'clock, with four or five of my inspectors, going to different stations that we could get into on this line, and all of them talking over the different circuits at the same time, all of them ringing over different circuits, and doing it all simultaneously, there was no interference. I have repeatedly gone to my office at night, taken this plug out of the switch and disconnected the systems from the ground entirely, got two, three, four and six people to talk at the same time on different wires on that circuit, and not one could hear a word that the other said—not as much cross-talk on that as on wires I have running down Carey street on the same pole. Now that is a fact. Of course, as I stated, I made inquiries from some of my electrical friends that I thought might possibly have heard of the adoption of this principle before I did, but it was new to them, as it was to me, and I never had seen any intimation of anything of the kind being done, in any of the public prints, although I am the subscriber to two or three technical journals. I then disclosed the plan to our executive officers and had a good deal of correspondence with them with reference to the matter before any decision was arrived at. During the progress of our correspondence I heard that Mr. Durant, of St. Louis, had tried the return ground system, and as it was told me, without any result. I was also told that an English electrician, a telephone man, had reported that in England they had tried the same thing and had found they obtained a better result by connecting the two ends of this common return wire to the ground also, using the earth and the wire together. Well that was a revelation to me. I thought possibly there might be something in it. I had not thought of trying it before, but I did try it, and just the very moment that the earth was connected on the wire again the same interference that we had before showed itself, but the very moment the earth was disconnected from the common return wire all this interference disappeared. I am only giving you facts, and facts that I have verified in every way that I can. Mr. Lockwood says he did not understand me to say that it was my intention or expectation to connect any considerable number of wires to the same line. I do propose to do that. I propose to have only one wire of large conductivity on every line of poles. It does not matter whether the pole carries twenty-five wires or two hundred and fifty wires.

Prof. VANDER WEYDE: I wish only to state that according to my experiments it is possible for twenty or thirty operators on a telephone line to communicate with one single return wire. My experiments were made five years ago in anticipation of the necessity of putting the wires under ground. I found that with one return wire I had as many as twenty or thirty different wires between which communication could be had, and that the call could be rung without mutual interference. Then I got, by the kindness of the telephone company, the use of a number of cables containing some hundred wires and a central wire. They call it the Patterson cable. But the results were unfavorable, for the reason that this cable was connected at both ends with the ground.

Mr. REILLY: I would like to say that something over three years ago we had occasion to run a common return ground, such as Mr. McClure described, to overcome the induction from the Delany synchronous multiplex telegraph on a line parallel with ours for about five miles. We ran a No. 12 copper wire for about four miles and connected to it six stations, and almost entirely overcame the noises from the telegraph wire and suffered no interference whatever from ringing from one station to another, and had no interference from cross-talk. That line is still in use and giving satisfaction.

Mr. SEELY: Mr. Lockwood referred in his paper to the great disadvantage and the great amount of trouble caused by dead wires hanging in the way. I would like to say that I think every city should have a subway commission. Of course we have one, though it is very much abused. But they are removing the dead wires fast in New York city; they take down the poles and wires, and the companies have no trouble whatever in removing the dead wire. They do it for them.

The secretary then read the paper of Mr. W. D. Sargent, as follows:

UNDERGROUND WORK IN BROOKLYN, N. Y.

The extension of underground conduits in Brooklyn has been restricted since my last observations on the subject to short sections, for the purpose of connecting our new buildings in the Brooklyn and Williamsburgh districts with the underground system. All of the new conduits have been made of creosoted wood, the ducts, 3 inches square, inside measure, with the exception of one short section of Macdonald creosoted wood, with round holes, 2¼ inches in diameter. It is fully decided, however, that hereafter no ducts will be laid with an opening of less than 3 inches in the clear.

In order to make ample room for the conduits reaching to our principal office, No. 16 Smith street, we have built a tunnel the whole width of the street, high enough and wide enough to walk through, and it now carries 108 ducts with room for perhaps 60 or 100 more. There are special features in this tunnel and method of bringing the terminals of the cables into the building which it is difficult to describe or to reproduce in a drawing. The *Electrical Review*, of Aug. 4, 1888, gives illustrations which will convey some idea of the character of the work, and the members of the Association are cordially invited to visit the office and inspect the arrangements for themselves.

The first sections of our creosoted wooden conduits have now been in service four years. There is no evidence of decay, and the ducts remain clean and dry, enabling us to draw in and withdraw the cables without any difficulty.

So far as the conduits are concerned, we think experience has fully sustained our judgment in favor of the creosoted wood.

One of the most important things, after the conduits, in underground work is the manholes, which should be as large and commodious as possible. Within reasonable limits it is almost impossible to get these manholes or working chambers too large. While, from the start, we realized the importance of this part of the work, we have, in quite a number of instances, been compelled to rebuild and enlarge the manholes as first designed. Given a conduit of durable material, connecting with commodious manholes, this part of the underground problem, so far, presents no serious difficulty.

The character of the cables to be drawn into the ducts and the method of distributing wires from them are questions that demand our most earnest attention. Experience has taught us that larger conductors and thicker insulation, together with twisted metallic circuits, are an essential part of perfect service. Conductors of .035 to .040 of an inch in diameter, insulated to .125 of an inch in diameter and twisted in pairs, with 100 to 104 wires, or 51 or 52 metallic circuits, make up a cable of from 2 to 2¼ inches in diameter. Such a cable will weigh between 4 and 4½ pounds per foot, according to the amount of lead and on account of the tendency of the lead pipe to buckle in bending we do not believe that it is practicable to handle cables of larger diameter and weight. The consideration of these facts led us to decide that our ducts should hereafter be 3 inches.

We are using nothing but the lead covered type of cable, some of which has been in service underground for four years and is still in good condition. Of the cables which were laid four years ago, those covered with pure lead appear to be more than half eaten through. One that has been drawn out during the writing of this article has been underground for two years and is badly corroded, there being holes eaten in it in many places nearly one-sixteenth of an inch in depth. Of the cables furnished by the Western Electric Company at the same time, in which there is a small percentage of tin mixed with the lead, the corrosion is very slight, and we are led to believe that cables covered with this alloy will last from three to four times as long as those covered with pure lead. We believe that, if in addition to the tin the cables were drawn through a bath of gas tar or asphaltum, then covered with a good stout braid and run through the gas tar or asphaltum again, the cables would be practically imperishable, so far as the outside covering is concerned, and it is a question whether this additional expense would not be justified by their increased length of life. It is certainly worth the trial.

The air-tight terminals which were put on all our lead cables more than a year ago appear to have removed all the difficulties which we formerly had at that point, and the tests of our cables, making due allowance for temperature, etc., show that there is no deterioration during the past year.

Of the cables mentioned by me last year, one of 7,180 feet, containing 100 wires, twisted indiscriminately, manufactured by the Western Electric Company, has been reduced by the change to the new central office to 6,344. Tests made Aug. 16, 1888, give an insulation of 800 megohms; capacity, .22 microfarads; resistance of the conductors, 43½ ohms per mile. The conductors are .038 inch in diameter, insulated to .088 inch. For a time during the past year all the conductors were in service, but recently the trunk lines to the Bedford office have been taken out, and there are now 80 wires working through it. The condition of this cable in regard to cross-talk is the same as last year. That is, it is not bad enough to prevent its use.

The cable manufactured by the New York & New Jersey Telephone Company, with 100 wires, twisted in pairs, has been reduced to 6,117 feet. Tests on August 19, 1888, give an insulation of 89 megohms per mile, capacity .275 microfarads, and the resistance of the conductors 48 ohms per mile; temperature in both these cases being, in the air, 80 degrees, and of the water from the hydrants 73 degrees. We assume that the temperature of the water from the hydrants is the temperature of the air in the conduits. Seventy-four wires are working through this cable, and the cross talk is no worse than last year, and is not so bad as to prevent its constant use. In both cases all the dead wires are kept grounded at the cable terminals.

The greatest length of cable we have now underground is 11,800 feet, between our Bedford street and Williamsburgh offices, consisting of 100 wires, twisted in pairs, the pairs broken up at all the splices; conductors .035 inch, insulated to .075. The insulation of this cable is 99 megohms per mile; capacity, .26 microfarads; resistance of the conductors, 47 ohms per mile. Seventeen conductors in this cable are in use for trunk service between the two offices, the rest of the wires being grounded close to the terminals at both ends. The cross talk in this cable is very slight and is indeed less than in the Western Electric cable of 7,000 feet. We received complaints from both these offices that the talking by subscribers through this cable was difficult and unsatisfactory. A special investigation of these complaints at the points they originated demonstrates that the difficulties complained of are not in the cable, but rather in the condition of the transmitters and instruments in the various offices and carelessness of the subscribers. Considering this cable as a whole, two miles in length, its electrical qualities are: Insulation, 50 megohms; capacity, .52 microfarads; resistance of conductors, 94 ohms. We are inclined to think this is about the limit of good working in that type of cable, and that the complaints we are getting about the service over it are due to the fact that it loads up the circuit so that there is no margin for any deficiency in the subscribers' circuits connected to it; whereas, if its efficiency were higher, there would be a margin to cover such defects, and complaints would be prevented. There is no doubt that the reduction of the cross-talk and the increase in the capacity is due to the fact that 88 of the 100 wires are grounded at the terminals, and that when the whole cable is put into service this condition of affairs will be changed more or less; that is, the capacity will diminish and the cross-talk will increase.

It was a consideration of the difficulties to be encountered in the use of greater lengths of this type of cable, which the above experience emphasizes, that decided us during the past year to make a special cable for our trunk lines, doubling the weight of copper and thickness of insulation. This resulted in our ordering three miles of cable, conductors .052 inch in diameter, insulated to .125 inch, 60 wires laid up indiscriminately, and during the past two months two miles of this cable, or 10,560 feet, have been put up on the elevated railroad structure, connecting the Brooklyn central office with the Bedford central office. The insulation is between 1,200 and 1,500 megohms per mile; capacity, .27 microfarads, resistance of conductors between 21 and 22 ohms per mile, at a temperature of 74 degrees. This cable, though of the same length as the one between the Bedford and Williamsburg offices, just mentioned, gives surprisingly better results, the cross-talk being very slight and the volume of sound full and strong. Forty of these wires are grounded at the cable terminals, and 20 are in active service.

There does not seem to be anything in the electrical measurements to indicate what causes the difference in the practical working of the two cables, but the results are gratifying and seem to plainly indicate that increasing the weight of the copper and thickness of the insulation is a step in the right direction, and I am inclined to think that grounded trunk wires of this last type may work successfully between our various Brooklyn offices, the distances between which do not exceed two and one-half miles.

All the new cables we have used this year have been of 102 wires, or 51 pairs, twisted, laid up in regular cable form, in alternating reverse directions, conductors .035 inch in diameter and insulated to .125 inch. The insulation of these cables when placed in position underground ranges from 1,500 to 2,000 megohms, capacity from .17 to .18 microfarads, and the resistance 52 ohms per mile. We believe that this type of cable will fulfill all the conditions required in our underground work, but at the present time we have no length sufficient to give actual working results.

The transition period between grounded and metallic circuit systems will be very troublesome and annoying, and may last several years. It is our intention in ordering the type of cable just described to make provision in the manholes for joining the sections together by devices which will enable the joints to be opened readily without cutting the cable and the pairs broken up in order to prevent cross-talk on grounded circuits, and, at the same time, allow of access to them for straightening them through when twisted metallic circuits are required. The necessity for getting at the joints in this way from time to time, and the space required to accommodate connecting boxes, is another argument in favor of large and commodious manholes.

The durability of lead pipe, with a slight mixture of tin, the maintenance of a uniform and high insulation, together with uniform resistance of conductors after four years of service, are indications of length of life that are very encouraging.

Up to the present time we have met with no serious accident in our underground work, either from explosions of gas or the men being overcome with foul air. We believe it quite likely that gas is not as plentiful in the streets of Brooklyn as it is in many other cities, and therefore the accumulation in the ducts and manholes is not so great; but we have been very careful not to spare any precautions that would insure our safety.

The Dorsett conduit, of which we have five miles, with ducts two inches in diameter, has proved to be very unsatisfactory, and the ducts, on account of inequalities at the joints, will only permit of a cable an inch and a quarter in diameter being drawn in. This reduces the capacity enormously, and is, therefore, a source of inconvenience to us.

It is plainly proved that the use of underground wires reduces the margin of good working very largely and will, therefore, require that extraordinary care must be taken to bring the service to its highest efficiency at all other points.

The most fruitful source of our trouble is the transmitter and battery, and while there have been very great improvements during the past year or two, there is still room for much more improvement before we reach perfection. The numerous contacts, in the magneto-bells and other apparatus, need especial attention and care, and platinum should be used wherever possible.

Another source of trouble is carelessness in running the wire from the insulator outside the building to the instruments in the building. The writer knows of many cases where the subscriber's wire is run through the window casing with the ordinary cotton covered wire and but little care taken in the inside of the building to keep it away from possible dampness.

As the mileage of underground wire increases, these and other faults, now overlooked, will become more and more apparent, and the expense of maintenance and inspection will be largely increased. There is only one way to bring back the easy working margin we have enjoyed on pole wires, and that is by the use of metallic circuits, and the sooner we get down to that basis, the better it will be for the service.

The following shows the actual extent of our underground work on Sept. 1, 1888:

	Miles.
Length of conduit	15.17
Length of duct	105.5
Length of cable	22.93
Length of conductor	2,053.3

Nineteen hundred and thirteen subscribers are working through underground wires, using 1,229.9 miles of wire.

This was followed by a paper by Mr. L. F. Beckwith, entitled

THE NEW YORK SUBWAYS.

In the following statement I have recorded a few data relating to the construction of electrical subways in the City of New York which may be of interest. The work was commenced in the latter part of 1886, and has been carried on since, with but slight interruption each year during the season favorable to out-of-door operations. The subways as laid out and built have been authorized and approved from time to time by the Board of Electrical Control, and the Consolidated Telegraph and Electrical Subway Company has been directed by the Board to construct them under its contract with the latter. The execution of the work has been intrusted by the above company to its sub-contractor, the Phœnix Construction Company, which has charge of all subway construction in this city.

The subways have been designed and laid out to meet the main requirements of the chief connecting or trunk lines of the various electrical companies so far as they could be ascertained, and so far as they could be conveniently grouped together. The principle of keeping the high tension electric currents for arc lighting and power in subways on one side of each street, and the low tension

electric currents for telephone, telegraph, and other purposes in subways on the opposite side of the street, has been laid down and so far adhered to. The question of distribution from the conduits has been wisely left by the Board of Electrical Control to the various electrical companies to express their preference for the method best suited to their special systems. This the companies have been repeatedly invited to do, and while some have responded, and their methods of distribution having been approved as reasonable and feasible, they have been accommodated as rapidly as possible; other companies have held aloof and refrained from action, apparently wasting precious time and neglecting to occupy and secure their commercial field and districts.

The subways built, except the Edison, are all on the "drawing in" system, which provides a group of tubes or ducts extending from one manhole to another, admitting of the drawing in and out of the electrical cables, and affording convenient access from the street. Different systems of grouping the ducts in the trench, and different materials have been employed, consideration being held of the importance of the line, the question of cost, the durability, tightness against water and gas, etc. Experience has shown us that a main conduit consisting of separate pipes which can be crowded or curved or kept apart is the best adapted to overcome the numerous obstructions met with under ground, and frequently diminishes the trenching necessary. Screw-jointed, asphalted wrought iron pipe laid preferably in hydraulic cement concrete present the greatest tightness of duct against gas and water, united with the greatest strength. The cement pipe and creosoted wood tubes present also features of great merit and adaptability. A special feature of New York Subway difficulties is the steam-heating underground system, of which the leaks in certain localities greatly interfere with the ducts and cables, precluding the use in such places of materials of construction, softening or melting at about 160 to 200 degrees F. In the case of long telephone lines, the desirability of comparing non-metallic and metallic ducts in respect to their influence on low tension currents has also been kept in view. A continuous line of telephone and telegraph subway is now completed about 7 miles long, and the above comparison can be made on 5 to 6 miles of this length.

The endeavor has been to provide a subway construction that will be most durable and that will give the best mechanical protection to the cables against injury from settlement of the ground, heat, water, gases, etc. The solution of the electrical question of underground working is one that relates to the manufacture of suitably insulated cables, and belongs properly within the province of the electrical companies.

The work accomplished up to September, 1888, is shown in the accompanying table:

Dorsett ducts, coal tar concrete	235,837 feet
Zinc tubes laid in hydraulic cement concrete	68,883 "
Creosoted wood tubes	167,175 "
Cement pipe laid in hydraulic cement concrete	216,626 "
Iron pipe laid in asphaltic concrete	131,284 "
Iron pipe laid in hydraulic cement concrete	1,423,722 "
Iron distributing pipe	23,301 "
Edison iron tubes	222,794 "
Grand total length of single ducts	2,489,602 feet
Grand total length of single ducts	472 miles
Grand total length of trenches	87 "
Number of manholes	523
Total length of telephone and telegraph ducts	376 miles
Total length of electric light ducts	96 "
Length of telephone and telegraph trenches	19½ "
Length of special electric-light trenches	17⅓ "

Besides the above there is still about three-quarters of a million feet of single duct for telephone, telegraph and electric light purposes authorized by the Board of Electrical Control to be built that remains to be constructed, besides contemplated lines.

The standard size adopted for telephone ducts is 2½ inches clear inside diameter, corresponding to a capacity of 100 wires, or 50 conductors in metallic circuit grouped in a lead covered cable. The chief portion of electric light ducts other than Edison ducts are 3 inches clear inside diameter. The manholes are all of brick laid in cement mortar with 8 to 12 inch walls and concrete bottoms. They vary greatly in form, and are from 8 × 12 ft. to 4 × 4 ft. 6 in. in size, and from 6 to 12 ft. deep. The street casting used has a double cover; the inner cover and rubber gasket are held down by a wrought-iron cross-bar, a bolt and padlock. The covers are practically tight against water.

The systems of distribution in use are as follows: For telegraph purposes, an iron pipe from a manhole connects underground with a building or with the foot of a pole. For telephone purposes the above method is used, and also in connection therewith, a pipe running up the face of a building to the roof, where, from a fixture, the cable is divided for distribution on the block and surrounding blocks. Sometimes the pipe is carried up through an elevator or ventilating shaft. In addition to the above, in the down-town district, and along Broadway to Union Square, an iron 3-inch pipe is laid in the trench above the subway, and provided at intervals of about 50 feet with malleable iron circular distributing or service boxes with screw covers 12 inches in diameter, with side outlets through which a cable can be conducted by a service-pipe into the buildings.

For electric light distribution the Edison Company have their special system laid. The "Johnstone" cast-iron distributing conduit, with six ducts and flush boxes, has been authorized to be laid in Broadway, from Fourteenth street to Thirty-fifth street, for purposes of electric light distribution, and will provide all the necessary facilities for this district.

Up to Aug. 27, 1888, there were 3,567 miles of wire laid in the subways by the Metropolitan Telephone & Telegraph Co. This company has laid a 100-wire lead-covered "Patterson" cable from Whitehall street to Fifty-eighth street, a distance of about 6 miles. This cable is believed to be the longest of this size in existence underground. The Western Union Co. have about 100 miles of wire underground, and the Edison Company about 126 miles. The Brush Electric Illuminating Co. are putting an 8-conductor "Standard" cable in the Broadway conduit from Fourteenth street to Thirty-fifth street, a distance of one mile, making 8 miles of electric arc light wire. Other applications for space in the subways and for the construction of additional electric light lines are pending.

Mr. E. F. Sherwood then read the following paper on:

THE TELEPHONE EXCHANGES OF NEW YORK CITY.

The Metropolitan Telephone and Telegraph Company has 7,300 subscribers, operated by eleven exchanges which are furnished with the following systems: John, Thirty-ninth and Harlem exchanges use the Western Electric multiple; Pearl, New Nassau, Murray and Twenty-first street exchanges use the Chinnock system; Spring street, the improved Chinnock system, adapted by Mr. Jos. P. Davis, formerly general manager of the company; Fulton and Beaver street exchanges use the Law system. The John street exchange has 799 subscribers and 40 trunks distributed among them. The Thirty-ninth street exchange has 1,108 subscribers and 39 trunks, and Harlem has 374 subscribers but no trunks terminating outside of the trunk sections. The reason that we have trunks at the two former exchanges among the subscribers is to connect the system with points not accessible or convenient to reach with trunk calling-wires.

To operate the boards during the busiest hours requires the following number of operators: John street, 14 operators, 57 subscribers per operator; Thirty-ninth street, 21 operators, 52 subscribers per operator; Harlem, 6 operators, 62 subscribers per operator; but counting the trunk wires according to the business done over the average subscribers' wire will be equal to adding 73 subscribers to John street, and 70 to Thirty-ninth street, thus increasing the average at John to 62 and at Thirty-ninth to 56. The reason we have a greater average at John and Harlem is that they are situated in the centre of business district, while Thirty-ninth street being a manufacturing and residence district a larger portion of the business is trunk.

We are using what we term trunk calling wires between the various exchanges, one terminating at John street and the other at Thirty-ninth street, for calling all trunk connections to the exchanges named.

There is an average of 3,000 connections per day called over each of these wires, and as each connection is ordered off again the number of orders is increased to 6,000. All of this work is done by two operators at each of these exchanges, and could be done by one if a whole section of the board was within her reach. We divide the trunks, one half being used for receiving and the other half for sending. Those we receive on are not multiple through the board, but end in cords and stand open at all times except when in use. When a number is called on any given trunk the connection is immediately made and is ready for ringing, this being done by the office calling, as we make the office where the call originates responsible for the connection. If the number called is busy we throw battery on the trunk, dropping the annunciator as a signal. We find this system very advantageous, as there is no delay in calling or clearing trunk connections and the service is made prompt, as shown by ten trunk connections made and conversations started with subscribers in six and one-half minutes.

At the exchanges which have the Chinnock system, each operator at the cases answers 100 subscribers and completes all local connections, using a local calling wire and a set of local trunks, which connect all the cases together. The calls for trunk connections are written on slips of paper and passed to the operators who control the trunks to the various exchanges. Ten trunk connections were made and conversations started through this system in twelve and one-half minutes.

The Fulton and Beaver street exchanges have, together, 410 subscribers, and are operated by nine operators and one chief operator. All local connections are completed by the operator who receives the call over the calling wire, and trunk connections are completed by the operator at the exchange for which the subscriber calls. The Law operator simply connects the subscriber's wire with the trunk wire and rings down the annunciator, when the operator answers and ascertains from the subscriber the number wanted. Ten trunk connections made through the Law system were completed and conversations started in 4¼ minutes, ten local connections in 2¼ minutes.

The number of trunk wires connecting the exchanges in New York City is 532 and average 60 connections per day, and as this average could be increased to 70 per day, the number of subscribers could be increased 600 without increasing the trunk facilities. To other exchanges we have 187 trunks, and with those the service is quite satisfactory and especially so with the new Brooklyn Exchange of the New York and New Jersey Telephone Company, and the service is prompt and satisfactory in every particular.

By the consolidation of the seven exchanges in the new exchange at 18 Cortland street, 206 trunks which connect these exchanges will be abolished, and the number of trunks to all other exchanges may be reduced, for the total number divided among the seven exchanges will not be required when they are all accessible to an operator in the new exchange. The new switch-board at No. 18 Cortlandt street will soon be completed and the consolidation of the seven exchanges made. It is wired for 5,100 subscribers and 900 trunk wires. The subscribers' operators will attend to 50 or 75 wires, according to the business done at different sections of the board. Trunk calling circuits to the other exchanges will be in operation, each receiving trunk operator attending to 50 wires. The local battery of each operator's outfit will be two cells of storage battery, one to be in use during the day and the other at night. The one in use during the day will be charged at night from the main storage battery, and the night battery will be charged from a dynamo during the day. All wires will approach the exchange through the underground system, the underground cables terminating in the cellar. From there they will be carried to the distributing board in the exchange by 334-conductor cables. The consolidation of the several exchanges will be beneficial in many respects. The service will be improved, the great volume of "sent" trunk business will be reduced from 20,000 to 8,000 connections, and the running expenses of the exchanges will be reduced about $2,700 per month.

One thousand five hundred and twenty-seven miles of wire are now under ground, and 2,784 separate wires are altogether or in part so working, most of which give general satisfaction. The underground facilities are rapidly increasing, 18 miles of 102-conductor cable running from 18 Cortlandt street to various points are now completed, and will be used when the exchanges are consolidated. Eight and three-quarter miles of the same cable will soon be run for trunks from 18 Cortlandt street to the other exchanges, thereby making the trunk service from this exchange entirely underground and doing away with the delays and expense of crossed and broken trunks, and will do away with the danger of crosses with wires carrying a heavy current, which proved so costly in connection with the burning of the Thirty-ninth street exchange, on which a few remarks may be of interest.

On May 23 the Thirty-ninth street exchange was set on fire by a cross with a wire carrying a heavy current and one and one-half sections of the board were burned out. The work of restoring the Western Electric multiple board after it has been burned and saturated with water can only be appreciated by those who have had to do it. In order to straighten out the wires it was necessary to make 1,260,000 tests, to splice 9,600 broken wires, to replace 16 cables which were destroyed from the switch-board to the cupola, and dry out the saturated portion of the board. The work of getting the lines in complete working order was delayed by the accumulation of line trouble while the troublemen were working in the exchange, but the switch-board and all the lines were in complete order two weeks from the date of the fire.

Mr. DURANT: I want to speak of the system we have in use between St. Louis and East St. Louis. The exchange at East St. Louis consists of only fifty subscribers, and about ninety per cent. of the traffic of that exchange is with St. Louis. Ordinarily in the Law system the trunk line business is done over two receiving wires, one from exchange A and exchange B, and the other from exchange B and exchange A, and we have that same arrangement between St. Louis and East St. Louis. However, the ordinary method is for the receiving operator to throw a telephone and transmitter into the sending call wire and give an order, expressed by numbers to the receiving operator. In the case of East St. Louis, which is occupied by an open circuit call wire which runs to the operator at the central office at East St. Louis, that line is extended—it is not grounded at East St. Louis—but it is extended to the receiving operator at East Louis. Consequently the order for traffic at East St. Louis is heard by both operators—by the one at East St. Louis and also by the one at St. Louis. The direction of the traffic is indicated by numbers. The numbering series at St. Louis commences at 100 and runs up to 5,000, while the numbering at East St. Louis is confined to the 5,000 series. When the subscriber at East St. Louis gives his order, of course the direction of the connection is expressed in the way given. That order is overheard by the operator at St. Louis, and without any word between them they select the lowest number idle trunk line, and the connection is made without any word passing between them. If any of you can beat that on the trunk line service we would like to know it.

Mr. SEELY: I would like to state, Mr. Chairman, that we are using a call wire precisely as Mr. Durant describes, with the exception of the St. Louis circuit. The operator, who could formerly handle only seven trunk wires, is at the present time handling fifty trunk wires. Instead of sending and receiving trunk wires she virtually becomes a switchman at No. 1 exchange, while the operators at No. 2 exchange are simply calling into her from the call wire. I presume the company is saving $10,000 or $12,000 a year in salaries on the trunk line system alone.

Mr. GIFFORD: I wish to inquire, to bring it down to the practical application, whether any one here has attempted to use the return ground wire—universal ground, in connection with the magneto system.

Mr. MCCLURE: There is no difference.

Mr. DURANT: Mr. Seely explained that this morning. He said they had tried it, and that the short and long wires interfered with each other.

Mr. GIFFORD: I am very glad the experiment has been tried and that somebody else has been to the expense before we have. I did not understand fully that it worked as satisfactorily with the magneto system as with the Law system. One is a magneto and the other a battery current.

Mr. MCCLURE: It doesn't make a particle more difference than it does between the earth and any system. You use the earth for any system and you use this artificial earth in precisely the same way.

The Secretary read the following paper by Dr. S. M. Plush:

THE TELEPHONE.

No discovery or invention was ever born at a time when the world was more ready to receive it than that of the telephone, notwithstanding which, great talent, perseverance and wealth were necessary to its successful introduction. The uncertainty which unfortunately hedged it about gave rise to temporary work and machinery, which has simply been renewed to the present time, and to-day the vast telephone system of the country is but a network of unreliability and temporary make-shift. Even the head centres or main exchanges (with but few exceptions), representing untold labor and expenditure of large sums of money in machinery and apparatus, are held by but a feeble tenure.

At that period but little time was given for consideration, and a forecast of what the future would be was difficult. The growth of telephone plants was without a parallel in any industry; the demands made upon them were greater than their means of supply; competent labor was not in the market and efficient machinery had not been devised.

The difficulty of meeting the requirements of a large number of subscribers at a given point early presented itself, and gave rise to a number of small exchanges, even in the most populous districts. This, together with the resistance on the part of the public authorities to the erection of necessary conductors, set the seal of fixidity upon what is manifestly a great hindrance to good and reliable service, while in nowise conducing to economy. The expense for rents, light, fuel, trunk lines and the introduction of so many additional connections into circuits call loudly for aggregation, and we believe the tendency is in this direction, and the time not remote when trunk lines will be known only as a means of reaching points far distant.

Probably the greatest drawback to-day to the complete development of our telephone systems is a growing tendency in legislative bodies to regulate prices to be charged for service, which, in effect, is simply to paralyze its growth and efficiency. Were the telephone the only means of communication, some regulation might be wise; such, however, is not the case—we have the postal, telegraph, and messenger service, each filling its own peculiar sphere, as regards reliability, speed and cheapness. The telephone should, so far as practicable, combine all of

these features, but neither should be sacrificed to the others; to regulate either must be at expense of the whole

When the field is once open to competition, that company which rigidly adheres to reliability and promptness in its service will not suffer through paucity of its finances.

Nothing in my opinion has operated more to the disadvantage of both the telephone companies and their subscribers than cheap rates. Many, through this means, have been induced to become subscribers to an exchange who have no real need for the facilities it affords. This lends a tone to their business, it is true, and serves in a measure as a card of respectability. Their place at once assumes an imaginary importance, and if there is any one thing that delights them more than another, it is having some real or fancied business with a leading and substantial firm. This they manage to have at frequent intervals, thus taking the time and monopolizing the wires of others, to their detriment and absolute loss. Important business is thus delayed and the value of the exchange materially lessened.

Busy houses to-day find it necessary to have some one in constant attendance at the telephone, and yet many calls are so delayed as to be useless. It is but fair, therefore, that their interests should have as many safeguards thrown around them as possible; that their conveniences and time may not be engrossed by frivolous questions in which they have no interest whatever. In other words, an exchange may be so large as to be comparatively worthless.

Constant effort towards speed, both of connection and disconnection, is being made, thus making a greater number of calls in a given time possible, and thereby removing the limit, which would otherwise soon be reached; but this limit must ultimately be reached, and what then? Even now requests for discrimination in making connections are not uncommon.

At the present growth of our largest exchanges the time must come when a more select means of communication will be demanded by the business public. That is, an "exchange" for business ("select," if we may so term it) where a party to become a subscriber will not only be required to pay his annual rental for service, but must hold a certificate of membership as well.

George Eliot remarks, that we began life, knowing little and believing much; a few years of experience, however, and in many cases the quantities are inverted. This aptly applies to every man connected with electrical science and mechanics, particularly the telephone and its environments. We live to-day in the same atmosphere we did ten years ago; nothing has materially changed, except ourselves, and we only in credulity. True, our experience has been great and varied, and has taught us in some instances how not to do it, and by this slow but certain method of evolution may in time teach us how to do.

It is difficult for us to realize that we are gradually making a history, and that the records of the great telephone must eventually be written; that we are each of us contributing thereto; that no matter how small a factor each may be, he is a part, and that at last his individual size must be determined by the magnitude of the whole. It behooves us, therefore, to see that the foundations of the telephone, which are now being laid, shall be solid and firm, that every right, every franchise, shall be permanent, every structure substantial, every centring point immovable and every method correct, and to this end the energies and intelligence of those associated with the telephone can be profitably directed.

Mr. DURANT: I do not believe there is a class of men in the world who appreciate the telephone less than the men engaged in the business. The reading of Dr. Plush's paper called to mind a statement made to me by the manager of one of the largest and best papers in the country, published at St. Louis. He told me that on the night of the earthquake—it occurred about 12 or 1 o'clock at night—that inside of two hours he called up 103 stations in various parts of the city, and got two columns of very interesting matter showing the effect of the shock in various parts of the city. That will perhaps show its value in one direction. The capacity of an operator under great stress was decided in our exchange, I think, last January, under the direction of Mr. Doolittle, and if any of you have not made that test I would suggest to you to make it, to show the number of connections that can be made in a given time by a single operator. On this test 53 were made in five minutes.

A MEMBER: How many do you suppose that operator could make in an hour?

Mr. DURANT: I suppose seven or eight hundred.

The application of the National Conduit Manufacturing Company for associate membership in the association having been approved by the executive committee, that company was admitted to the association.

By a vote of the Association Minneapolis was selected as the place of meeting next year.

The following paper by Mr. McCully was then taken as read:

AN INTERESTING JUDICIAL OPINION AS TO THE RIGHTS OF A TELEPHONE COMPANY AGAINST HOUSE MOVERS.

Frequent demands have for several years back been made on the New York & New Jersey Telephone Company for removal of its wires to make way for buildings passing through the streets. Any individual desiring to move a building may apply to the local authorities for permission to do so, and almost invariably his wishes are granted and permit issued. Armed with this permit the house-mover presents himself a few hours before he reaches the point where the wires intercept him and demands that they be removed. The position heretofore taken by the company was that while it was under no obligation to remove the wires without the payment of costs, yet as a matter of policy, it was not deemed wise to stir up a sentiment which would surely be adverse to the corporation and favorable to the "poor house-movers." As the number of pole routes increased, and wires were from time to time added, these interruptions to the service became more and more aggravating, and the actual expense also became a matter for consideration, so that finally local managers were notified that no wires could be removed unless house-movers would guarantee the cost. In view of this decision, it may be interesting to other companies which have suffered from a similar annoyance to note the result of this move, and, in some measure, a test case which grew out of it.

In the month of October, 1887, the company was notified by one Dexheimer, of Orange, a house-mover, that he was about to move a building through Oakwood avenue, Orange, N. J., and in order to give free passage, a telephone line of 78 wires and a 50-wire lead cable would have to be temporarily removed. At any price the company would object to such an interruption as this would cause, but agreed to open the way upon a guarantee of payment of costs, which should not exceed, in any case, $25. Dexheimer stoutly refused to make the guarantee, assured by the counsel that he had the necessary permit, and that wires were an obstruction to the highway and might be removed by himself, if found in the way. On Sunday morning, Oct. 30, 1887, the building had been brought within a few feet of the wires, and neither the company or Dexheimer had changed their positions. It was not supposed that Dexheimer would cut the wires; but seeing that the company made no move to clear the way, he nipped them one by one with pliers and finally cut the cable, leaving a clear passage. The line slacked up badly for a distance of ten or twelve poles on either side of the gap, and presented a wretched appearance. The company's counsel soon after brought suit against Dexheimer for damages, and the case came to trial before Judge Depue, in the Essex Circuit Court. The ordinance of the City of Orange regulating the erection of telegraph lines—and of this ordinance the company's counsel was not ignorant nor unmindful—directs that wires should not be strung over street crossings at a less height than 20 ft. above the ground, and on this point the merits of the case seemed to turn. It was admitted by the company that some of the wires were below the height required by the ordinance, but that at least 30 wires were above the 20 ft. required. Inasmuch as these 30 wires were cut, Dexheimer had acted in violation of law and was liable for damages. The company's witnesses testified that the poles were at least 25 ft. out of ground, and allowing the centre of top arm to be 8 inches from the top of pole, and the centre of second arm 28 inches from top of pole, and still allowing 24 inches for a depression where poles stood below the level over which the wires were strung, it was claimed that the 30 wires were over 20 ft. in height at the middle of the span. The arms referred to were double 10-pin arms. Dexheimer, on the other hand claimed that he cut all the wires while standing on the second floor of the building; that the timbers on which the building rested were 3 ft. high, the first story 9 ft. and his own height 5 ft. 10 in. The jury rendered the verdict that the company was not entitled to damages, accepting Dexheimer's evidence as to height of wires rather than that of company's witnesses.]

As the verdict appeared to be against the weight of evidence, motion for new trial was granted.

As the case stands now, however, *one* very gratifying result has been attained, the law as to use of public highways being clearly laid down in Judge Depue's admirable charge to the jury. Telephone companies have chartered rights, subject to local regulations. When these regulations have been complied with, wires are not an obstruction under the law. Any interference with wires under these circumstances would make the house-mover accountable for damages.

The subject of the various modes of taxation of telephones companies in vogue in different States was then discussed by Messrs. Kerr, Bailey, Durant, Drake, Metzger and Gifford, and after accepting the secretary's statistical report, the Convention adjourned *sine die*.

EXHIBITS.

The Okonite Company made an excellent showing in Rooms 11 and 12 of their leading specialties for electric service, especially their telephone wires and cables, which have now gone so extensively into use.

The Union Indurated Fibre Company, of New York, exhibited in Parlor 7 samples of their product for conduits, battery jars, etc. The pipe they make is free from long fibre, and is molded into shape under heavy pressure, and by chemical treatment and vitrifying process it is hardened and rendered waterproof and absolutely indestructible. Such a pipe evidently has its place in the electrical field, and it is not surprising that the company should be in receipt of extremely large orders, as well as having—as Mr. Robert Coleman reports—extensive negotiations in hand.

The New York Insulated Wire Company made a display in Parlor 7 of their insulated wires and cables, including the Grimshaw patent white core wire and cables. These specialties are familiar not only to telephone men but to electric light and telegraph people.

Mr. H. D. Stanley, of the Bridgeport Brass Company, had for distribution some very interesting tables compiled from a series of actual tests made by himself of the stress in pounds on a span of the company's hard-drawn bare copper wire for any given dip from 2 to 30 inches when in a state of absolute rest, and for spans of varying length.

The Western Electric Company occupied Parlor 2. They made a fine display of all their leading productions pertinent to the telephone industry. Among these may be mentioned their cable switch wires, terminals, Patterson cables, etc., switch-boards, magneto bells, long distance boards, etc. They distributed as mementoes very neat and tasteful paper weights, composed of sections of Patterson cable on a black base. These were eagerly sought for, and will now adorn many an electrical desk.

The H. B. Cox Electric Company, of New Haven, Conn., had an exhibit in Parlor 7 of their gelatine battery, which is well known to all users of primary batteries. It will be remembered that in this battery the material used to hold the chemicals in solution is of a gelatinous nature.

The Standard Underground Cable Company had an exhibit of their lead-covered wires and cables in Parlor 5, and of the Acheson protector for cables against disruptive discharges.

The Law battery was on view in Parlor 5.

CONVENTION NOTES.

An extremely enjoyable part of the convention was the long-distance entertainment given by the American Telegraph and Telephone Company on Wednesday, supplemented by the dinner tendered by the Western Electric Company. Six tally-ho coaches started from the Hotel Brunswick at 3:30, and with a load of passengers inside and out made their way up Fifth avenue, through the Park to Seventy-second street, thence to Riverside Drive up to Grant's tomb. There the party dismounted to inspect the tomb and the surroundings; and as the visitors looked down from the high bluff through the trees and the lawns to the winding Hudson below, they agreed that at least no lovelier spot could have been found for the great warrior's resting place. Remounting, the party proceeded by the Boulevard to 155th street, having an opportunity on their way to admire the beautiful long distance lines running up that way, and then they came back to the Park by St. Nicholas avenue, 125th street, Seventh avenue and 110th street. On arriving at the Mount St. Vincent Hotel, the excursionists were photographed in a group on the lawn at the back of the house. A pleasant half hour was spent in discussing the various incidents of the drive which the American Telephone Company had given, and then came the call to dinner, which was served in the large banqueting hall at the southern end. Mr. Thayer, the well-known representative of the Western Electric Company, took the chair, supported by Messrs. Metzger, Barney, T. N. Vail, Sargent and Storke, and at the ends of the two longest tables sat Mr. Brown and Mr. Patterson. An excellent dinner was served in first-class style, accompanied by four wines, etc., and Mr. Thayer having said a few hearty words of welcome on behalf of the Western Electric Company, Mr. Dutton assumed his duties as toastmaster. Mr. C. Jay French responded briefly for the American Bell Telephone Company, and presented the regards and kind wishes of such of its officers as were absent. Mr. Morris F. Tyler then spoke to the toast of the Eastern licensees of the parent company, and referred very eloquently to the benefits that the telephone conferred on the public. He also reminded his hearers that their business to-day was based, as a valuable property, on one of the most magnificent fights ever seen in the courts anywhere in the world, and though the fight had been made with the licensees' own money [laughter] the parent company had made it successfully, with no little skill, no little shrewdness, no little stern confidence in the justice of their cause. Mr. George F. Durant then responded humorously for the Western licensees, and Mr. C. J. Glidden replied for the Erie Company, representing interests in other sections. Mr. T. D. Lockwood spoke with his accustomed humor and vivacity on the subject of the telephone, and hit off neatly the characteristics of many of the famous 37 men who had all invented the telephone before Prof. Bell did. He quoted aptly Milton's well-known passage relating to the invention of cannon as applicable to the invention of the telephone, and after eulogizing Prof. Bell very felicitously, spoke in warm praise also of the great work done by Mr. Emile Berliner in the matter of battery transmitters and the use of the induction coil. Mr. W. J. Sefton, of the Subway Board, then responded as to the underground wires of the past, and Commissioner Gibbens drew a glowing picture of the underground telephone work of the present, paying the telephone men a handsome and deserved compliment for the assistance they had rendered in such of the work as had fallen to the share of the New York subway board to do. Mr. R. W. Pope then spoke as an electrician who was a telegraph man among telegraphists, an electric light man with electric lighters, and a telephonist among such as he saw around him, and he remarked that it was a good sign to see the various electrical interests drawing closer together for mutual welfare and support. He made a strong appeal for good work and the use of the best material, and assured his hearers that with good service they could hold their own against all comers. Mr. Storke then replied briefly for the National Telephone Exchange Association as its treasurer. Mr. F. W. Jones, of the West Coast Telephone Company, spoke for South America, mentioning Mr. T. N. Vail, whose name several times during the evening elicited tremendous applause. Mr. De Groot, of Antwerp, spoke for the International Telephone Company, recommending greater and closer union among telephone men. Mr. W. A. Hovey replied gracefully, as an old journalist, for the press, and earnestly recommended that whenever his telephone friends saw misstatements about their business in the papers they should correct them. Otherwise they were themselves to blame, for any editor of a reputable paper was always willing to rectify a mistake or make proper explanations. Mr. Metzger then made a fitting acknowledgment in behalf of the gathering, of the splendid hospitality of the Western Electric Company, as well as of the earlier entertainment of the afternoon, and Mr. Brown replied for the company. He regretted the absence of his chief, Mr. Barton, now on his way home from Europe, and paid to Mr. Barton a tribute for manliness, integrity and ability that evidently had the full support and endorsement of the whole enthusiastic assemblage. The dinner was then closed by Mr. Hibbard, who started "Auld Lang Syne," in which all joined heartily, and then at midnight coach after coach rolled off through the green glooms of the Park, brimming over with humanity in its most festive and frolicsome mood. It was a royal evening all through.

On Thursday, at 10:30 A. M., about 250 guests of the Metropolitan Telegraph and Telephone Company embarked on board the steamer "Cygnus," of the Iron Steamboat line, at West Twenty-third street. The steamer then headed up stream, and the party were soon delighting themselves with the scenery of the Hudson River, as it unrolled in all its varied picturesqueness of woodland and meadow, busy towns and secluded mansions. An excellent band performed at frequent intervals. About 12:30 a very substantial collation was served on the saloon deck by Mazetti, and it was not the less enjoyed because the river air was fresh and cool. The boat went up as far as Croton Point, and then returned, making a stoppage at Twenty-third street about 4 P. M. for such as desired to go ashore. The number was, however, very few, and the boat then made her way to Staten Island. After cruising down the bay, the steamer put in at the St. George's Casino wharf, and about 6:30 P. M. an excellent dinner was served in the Casino to about 250 gentlemen.

There was not much time after dinner for speechification. Mr. Theodore N. Vail was called upon with three cheers, but declined with smiles to do more than preside. Mr. Erastus Wiman made a neat speech, referring facetiously to the dinner as an evidence of the money to be made in telephony, and expressing his belief in a closer identity between the telegraph and the telephone. He was followed with brief remarks by Mr. A. B. Chandler, Gen. Barnum, Commissioner Gibbens and Commissioner Hess, of the Subway Board. Mr. Charles A. Tinker, Mr. W. H. Eckert and others called upon limited their responses to bows and waves of the hand, and at 8:30 the party went to the grand stand, and obtained a vivid idea of what would have been the value of telephone patents under a Nero who wanted everything for himself that could in any way be valuable to his subjects. This representation of the spectacular piece was greatly enjoyed, and thus a memorably pleasant day reached its close.

Among the prominent guests not already mentioned, and in addition to those listed as in attendance on the convention, were Messrs. G. G. Ward, De Castro, Rosener, and Huidekoper.

A Picturesque Central Station.

The illustrations on this page show the exterior and interior views of the station recently completed by the Thomson-Houston Electric Company, of Boston, for the Narragansett Pier Electric Light and Power Company, of Narragansett Pier, Rhode Island. As is readily seen, the outside design of the station, Fig. 1, is novel, and is fully in keeping with the architecture of the hotels, Casino and cottages of that wealthy resort.

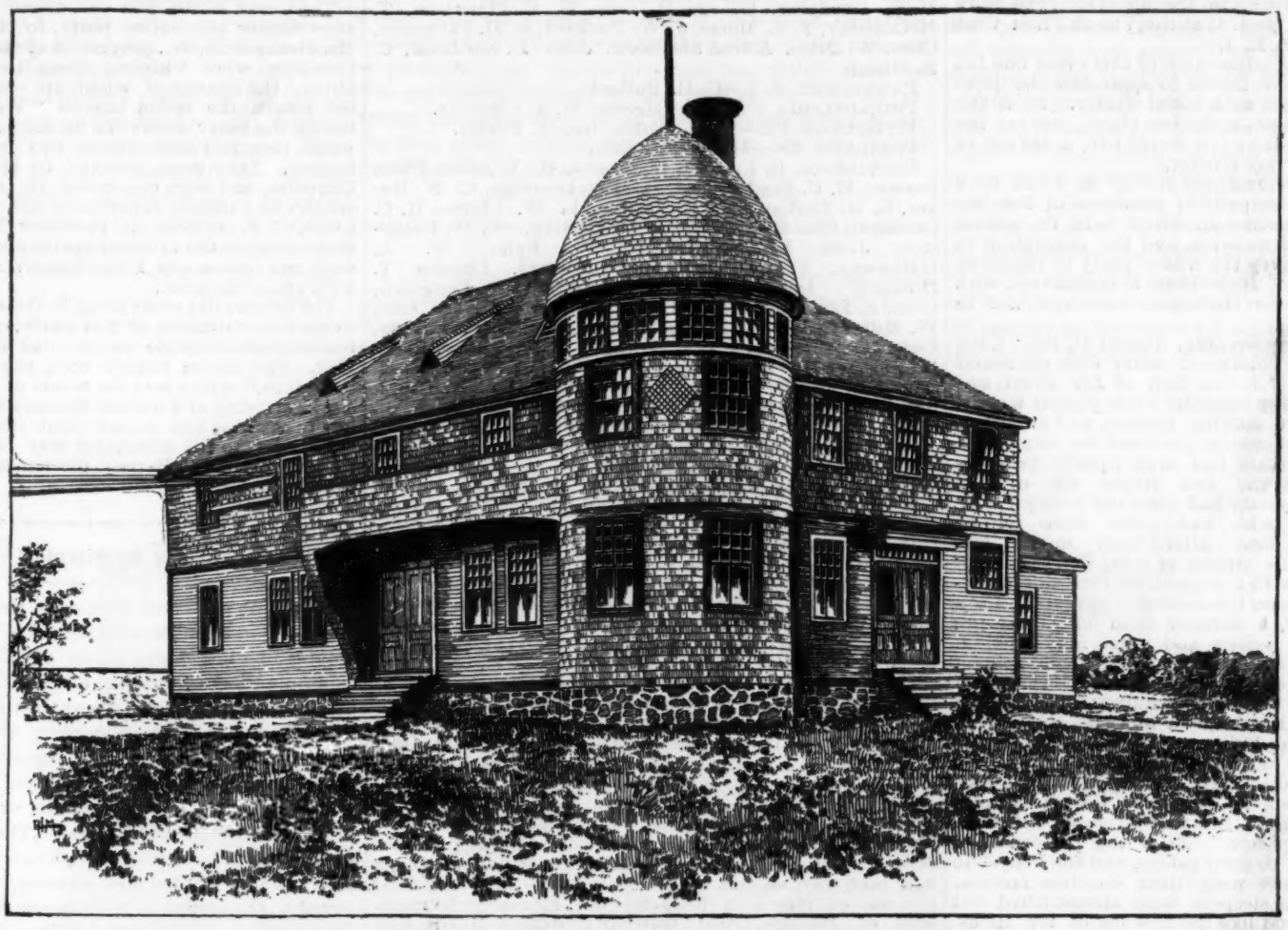


FIG. 1.—VIEW OF STATION, NARRAGANSETT PIER, R. I.

The engine and dynamo room, Fig. 2, is finished in white wood, and its arrangement is similar to that used to a great extent on many other Thomson-Houston stations. The present capacity of the plant is 2,500 incandescent (alternating) and 50 arc lamps, and ample room is left to add steam plant and dynamo capacity sufficient to operate as many more. The second story is used as a stock and lodging room, three nice chambers being fitted up for the use of the employés, the superintendent occupying the one in the tower, directly over the office. There are few rooms at the Pier which surpass these for comfort and for a fine view of the ocean.

By an arrangement made by Mr. Burleigh, of the Thomson-Houston Company, who had charge of the installation of the plant, all the incandescent lights can be thrown on one machine during the latter part of the night, thereby giving to patrons all the service needed at that time, and permitting all the engines and dynamos except one to be shut down.

The steam plant was furnished by the Jarvis Engineering Co. and is complete in every respect, being fitted with muffler, extra valves, damper-regulator, etc. The outside construction extends from the Boston Neck road on one side to the elegant cottage of Mr. R. G. Dunn, on the Pt. Judith road, on the other, and thoroughly covers the district from the water front back towards Wakefield.

All the hotels, Casino and many of the cottages have adopted this method of lighting and are very much pleased with the result, the largest patron being the Casino, which is using nearly 450 lights, and which has given the company a contract for five years for lighting the building. Many owners of cottages are now leaving orders to have their residences wired during the coming winter, and the outlook for 1889, added to the very successful start of this year, makes the prospect of this plant most flattering. Although the largest amount of business will be done during the summer months, the station will be run the entire year. The construction of lines is already under way to connect the plant with Wakefield and Peacedale, only two miles distant, where a large business will undoubtedly be secured, as a large number of lights which are used in the summer and not in winter can be successfully introduced into several of the large mills there. Construction work was commenced April 25, and the lights were turned on June 20. The officers of the company are: President, John Babcock, Wakefield, R. I.; treasurer, John B. Kearney, New York; directors, John Babcock, Wakefield, R. I.; John B. Kearney, New York; Edw. Earl, New York; William C. Clark, Wakefield, R. I.; Thos. T. Robinson, Boston, Mass.

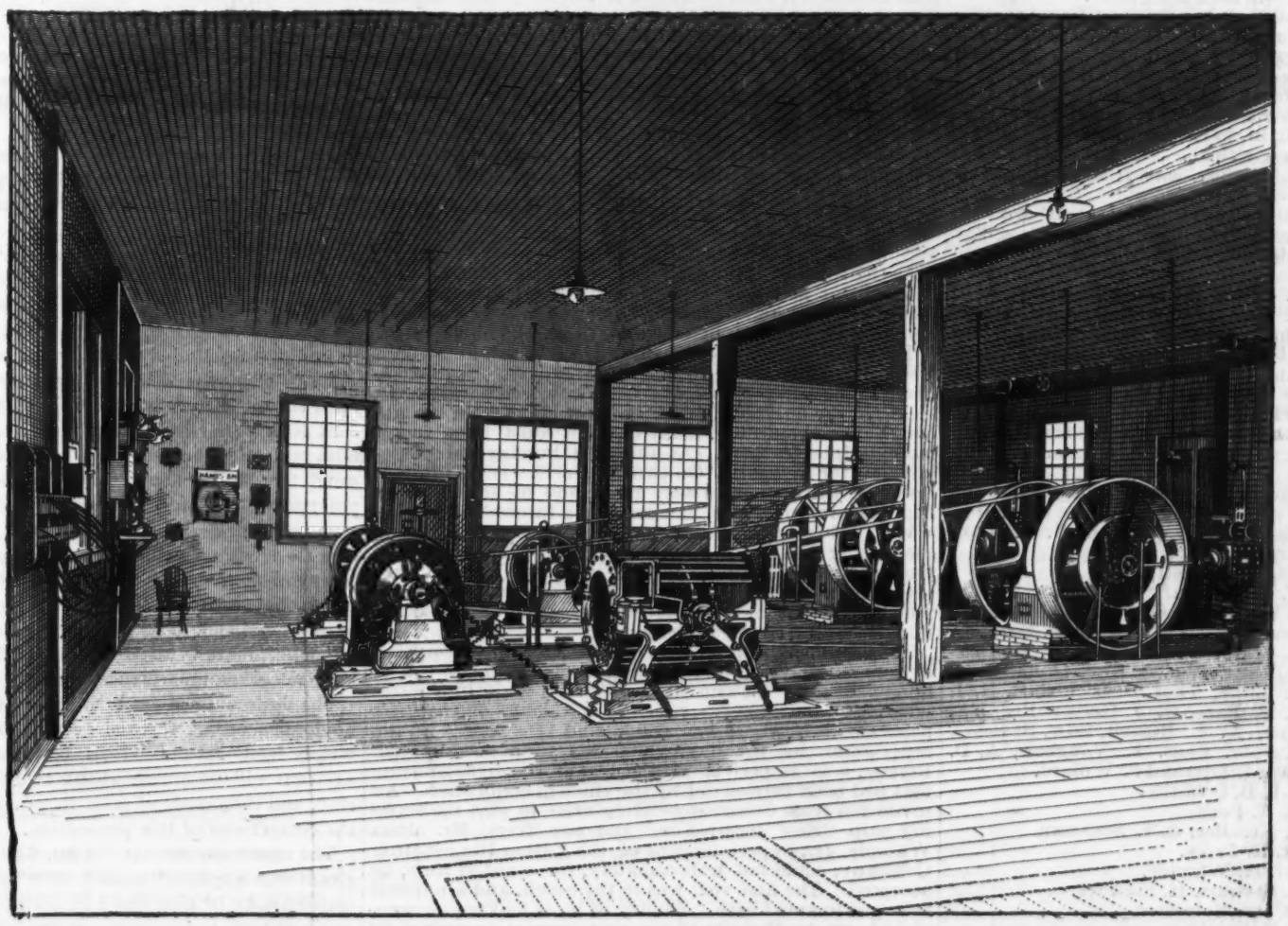


FIG. 2.—INTERIOR OF STATION, NARRAGANSETT PIER, R. I.

A New System of Telegraphing with Lightships.

It is well known that considerable difficulties are found in effecting telegraphic communication with lightships, and even with lighthouses on rocks at a distance from the shore. Mr. Willoughby Smith has, however, devised a method of effecting the object, which he has protected by patent, and which may probably be applicable to other purposes. He points out that at the present time, wherever electric telegraphic communication is established between the shore and a lighthouse, either floating or on a rock at a distance from the shore, it is effected through an insulated conductor or a telegraph cable; but much difficulty is experienced, owing to the rapid wearing of the cable, so that it is liable to break whenever a storm comes on, and when consequently it is most required to be in proper working order. By his invention he is able to effect communication between the sending station and distant point without metallic connection one with the other.

This is effected in the case of a lighthouse erected on a rock at a distance from the shore by submerging one or more metallic plates or masses on opposite sides of the rock, so that the two plates or sets of plates may be as far apart as practicable, and from each plate or sets of plates he leads an insulated conductor to a telephone in the lighthouse. A two-conductor cable is led from a signal station on the shore toward the rock. At a distance from the rock one of the conductors of the cable is led to a metallic plate submerged on one side of rock at such a distance from it as to be in water deep enough for it not to be affected by waves. The other conductor of the cable is similarly led to another metallic plate or mass similarly submerged at a distance from the opposite side of the rock.

To communicate from the shore to the lighthouse an interrupter or reverser and battery are connected to the shore ends of the two insulated conductors, and the telephone in the lighthouse responds to the repeated makes and breaks or reversals of the current, so that communication can readily be carried on by the Morse alphabet. If a vibrating interrupter or reverser be used a short or long sounding of the telephone can be obtained by a contact key held down for short or long intervals. A more convenient way is to use two finger keys, one of which by a series of teeth on its stem, or in other more convenient way, produce a few breaks or reversals of the current, while the other key when depressed produces a greater number of breaks or reversals.

In the same way communication could be carried on from the shore to a vesse at a distance from it, if the vessel were in the vicinity of two submerged plates or anchors, each having an insulated conductor passing from it to the shore, and if two metallic plates were let go from the vessel, so that these plates might be at a distance apart from one another. The position of the two submerged plates coupled to the submerged insulated conductors might be indicated by buoys. In this way communication might be effected between passing vessels

and the shore, or between the shore and a moored light-house or signal station. A similar result might be obtained with a single insulated conductor from the shore by the use of an induction apparatus with the ends of the secondary winding coupled by insulated conductors to submerged plates at a distance apart.

The Clambake of the Year.

The tenth annual clambake given by the American Electrical Works, of Providence, to the electrical fraternity took place on Saturday, Sept. 1, at the Vue de l'Eau Club on the Providence River, R. I.

To properly realize the importance of this event one has to live for awhile in Rhode Island to appreciate the powerful influence of the clam as a social factor. It is the fetich of some of the most exclusive clubs, and to the Rhode Islander the clambake is a sacred rite, a season of unclouded sunshine, a "joy forever."

New York was to be represented at Vue de l'Eau by a delegation composed principally of members of the National Electric Light Association, which held its session last week at the Hotel Brunswick, and the suggestion to charter a steamer to convey the whole party to the scene of action was no sooner made than a committee, with General C. H. Barney as chairman, was organized to carry it out.

At six o'clock on Friday evening, August 31, the "Catskill," bright with flying colors and merry with the sound of music, left the wharf at the foot of Jay street, and turned her head toward the beautiful Narragansett waters. The committee had left nothing undone, and an atmosphere of satisfaction and content pervaded the ship. Keen appetites and thirsty throats had been equally well provided for, and before the first dinner was over it was evident that everybody had come out to enjoy himself, and that those who had come were on no fool's errand. The first afterd-inner smoke was hardly finished before the strains of "St. Patrick's Day" were heard coming up with a suggestive vim and cheerioness from below, and soon the musicians appeared. They were the vanguard of a devoted band of life-saving brethren clad in cork jackets and other impedimenta. Ever and anon they seemed to have a pressing engagement with the Governor of North Carolina, or the Governor of South Carolina ,or both, which necessitated their rapid exit and prolonged absence, but finally a minstrel séance was organized with Mr. Frank Ridlon as "interlocutor." Songs were sung, poetry was read, recitations were given, and conundrums were propounded. One of these was: Why does Frank Ridlon resemble the proprietor of a well-known New York theatre? Answer.—Because he looks like a "toney pastor." After this performance, the early birds went off to their cabins, and the "boys" to renew their acquaintance with their Carolina friends. About 3 o'clock A.M. the sleepers were almost lifted out of their berths by a sound like the howling of ten thousand Walhallan gods. It was, however, only a tender message from Carolina, in the shape of a serenade with tabret and dulcimer, or rather with the ship's gong and the big drum, and if the phrase "Making night hideous" had hidden meanings before, it certainly now has none for those who spent that night on the steamship "Catskill."

Owing to a very thick fog, and in view of the chances being that the boat would not arrive at Providence in time for the "bake," the committee thought it advisable to put into Stonington, so as to give those who wished to do so an opportunity of taking the train. About thirty did this, and arrived at Vue de l'Eau soon after noon.

The "Catskill" proceeded on her way and found the fog even more dense as she neared the ocean. It was still a question whether she would reach Silver Spring wharf in time for the festivities, so the relief to the passengers when they saw the entrance to Narragansett Bay can be imagined. The weather soon cleared up and the boat made good time, coming in, to the surprise and delight of every one, soon after two o'clock. She was piloted into Silver Spring by General Barney, who from boyhood has known every part of these waters.

The reception committee opened wide their arms to welcome those they had looked upon as their long-lost brethren, and a procession was formed up to the club-house, to the music of a triumphal march by "our own particular" brass band. Up at the club house there were more cordial greetings, then prompt and conscientious sampling of the preliminary goods things provided, and archery, rifle shooting, base ball, and the usual hat games until dinner was announced. One esteemed member of the Catskill Committee was relieved of three different pieces of headgear, and had at last to resign himself to allowing the breezes of heaven to play unchecked through his luxuriant tresses. According to custom a group photograph was taken.

The tables were spread in a large tent contiguous to the club-house, and in due course the guests were ushered in and the serious business of the day commenced. The following were among those present:

ATTLEBORO, Mass.—H. M. Daggett, Jr.
ASHEVILLE, N. C.—T. W. Patton.
BOSTON, Mass.—Geo. W. Adams, Geo. B. Appleton, Jr., Chas. L. Bly, F J. Boynton, E M. Bryant, Chas. Burgher, J. H. Clarke, Henry B. Cram, W. J. Denver, J. W. Duxbury, P. Fahey, F. A. Gilbert, Wm. S. Key, D. Killicutt, Mark S. Lewis, N. W. Lillie, Thos. D. Lockwood, H. J. Miller, Geo. B. Neal, C. M. Ransom, J. Herbert Redding, Frank Ridlon, R. F. Ross, A. L. Russell, Edw. S. Sears, Suel Smith, M. W. Turner, Chas. E. Vaughan, A. D. Wheeler, W. C. Woodward, Edmund S. Willard.
BRIDGEPORT, Conn.—T. B. Doolittle.
BROOKLYN, N. Y.—E. F. Peck.
CHICAGO, Ill.—W. A. Kreidler, A. L. Suesman.
CINCINNATI, Ohio.—A. R. Foote.
DETROIT, Mich.—Fred. H. Whipple.
ELIZABETH, N. J.—R. Stewart, H. Stewart.
FALL RIVER, Mass.—Chas. Sylvester.
FREMONT, Ohio.—W. R. Caulkins.
HARTFORD, Coun.—J. J. Gates, C. G. Perkins.
HAVERHILL, Mass.—E. P. Jacobs.
HOUGHTON, Mich.—Jas. R. Dee.
LEADVILLE, Colo.—H. B. Slater.
LOWELL, Mass.—Chas. E. Adams, J. Y. Bradbury, Chas. J. Glidden, Jas. Murkland.
LYNN, Mass.—Herman Bergholtz, Geo. F. Curtis, John Tregoning.
MILLBURY, Mass.—John Geigenheimer, C. D. Morse.
MONTREAL, Can.—H. S. Thornberry.
NEW BEDFORD, Mass.—R. S. Taber, W. K. Wagner.
NEW HAVEN, Conn.—E. B. Baker, Attwater T. Barnes, Geo. S. Barnum. E. N. Clarke, C. W. Clapp.
NEWARK, N. J.—C. O. Baker. Jr., Geo. A. Tobey.
NEWPORT, R. I.—J. Carroll, H. F. Kellogg, J. D. Richardson, Jr.
NIAGARA FALLS, N. Y.—Mr. Rhodes.
NORTH ATTLEBORO, Mass.—L. W. Dillon.
NORWALK, Conn.—Emo A. Smith.
NORWICH, Conn.—L. W. Phillips.
NEW YORK, N. Y.—P. C. Ackerman, P. H. Alexander, George W. Arnold, Jr., C. H. Barney, E. G. Barnard, C. H. Bogle, E.W. Carritt, Wm. F. Cullen, Henry C. Davis, M. W. Goodyear, George H. Guy, B. F. Hamilton, T. McCoubray, F. E. Morse. J. W. Packard, A. H. Patterson, Chas. W. Price, Alfred Shedlock, John D. Shedlock, C. E. Stump.
PAWTUCKET, R. I.—C. H. Bullock.
PHILADELPHIA, Pa.—Carl Hering, H. A. Cleverly.
PITTSBURGH, Pa.—M. M. Ogden, Geo. F. Porter.
PORTLAND, Me.—H. W. Hamblin.
PROVIDENCE, R. I.—Geo. H. Adams, B. L. Allen, Chas. Benson, H. C. Bradford, H. A. Breckenridge, C. W. Baker, E. M. Carhart, F. E. Chafee, L. W. Clarke, H. C. Cranston, Geo. H. Darling, J. O. Darling, W. W. Dempster, John I. Drake, E. W. Fyler, W. A. Hathaway, F. C. Holst, H. Howard, Charles T. Howard, Isaac Kirbey, Henry C. Langstaff, Chas. E. Lincoln, Alex. McLellan, G. F. MacKinnon, Geo. W. Millard, W. N. Munro, L. W. Paige, S. R. Payson, Chas. G. A. Peterson, E. C. Perkins, E F. Phillips, E. R. Phillips, C. R. Remington, Jr., W. H. Sawyer, H. H. Sherman, E. Tobey Stowe, Royal C. Taft, Geo. H. Thurston, V. A. Thomas, C. H. Wagenseil, A. C. White.
SAN FRANCISCO, Cal.—A. F. Smith.
SPRINGFIELD, Mass.—Alex. P. Wright.
SYRACUSE, N. Y.—F. H. Leonard, Jr., A. P. Seymour.
TAUNTON, Mass.—D. L. Mitchell, C. A. Williams.
WASHINGTON, D. C.—Fred W. Royce.
WOONSOCKET, R. I.—Jas. H. Cary.
WORCESTER, Mass.—Henry M. Smith

Mr. Eugene F. Phillips introduced Governor Taft, who gave a hearty welcome to the visitors, and assured them that although Rhode Island was a good place to come to for a day, it was still better as a home, and to give a finish to its attractions it had plenty of young ladies.

Three cheers were given for Governor Taft, three more for Mr. Phillips and three for the ladies. Telegrams or letters of regret at inability to be present were read from Mayor Robbins, ex-Secretary of State; J. M. Addaman, N. S. Possons, H. Bull, Jr., W. J. Johnston, T. C. Martin. J. Wetzler; also a letter from John I. Sabin, of San Francisco, which was accompanied by a check for $20, with a request that the money be spent in the purchase of flowers for the decoration of the tables, the pretty appearance of which bore evidence to the manner in which this wish had been carried out. Ex-Governor Howard extended the use of rooms in the Telephone Exchange to members of the electrical fraternity during their stay in town, and Mr. Bull's letter contained an invitation to a drive around Newport on the following day, an invitation which was gladly accepted. Mr. H. C. Davis was then introduced, and presented to Mrs. Phillips, on the part of the New York delegation, as a mark of their appreciation of the hospitalities tendered them, a handsome cut-glass salad dish, and to Mrs. Sawyer a beautiful set of cut glass dishes, products of the Phœnix Glass Works. Ex-Governor Howard responded on behalf of Mrs. Phillips, and Mr. Sawyer returned thanks on behalf of Mrs. Sawyer. Mr. H. C. Davis, in a humorous speech, then presented to Mr. Phillips and to Mr. Sawyer large shining diamond pins, said to be 550 carats each.

In the meantime the feast had proceeded apace, and the diners had got in their fine work on the clams, and all around was joyous and serene, when Ex-Gov. Howard, in a cordial speech, remarked that to the new words, such as volt, megohm, ampère, etc., coined to express electrical meanings, they should add a synonym for kindly feeling and generous hospitality in the word "Phillips." Speeches were also made by T. D. Lockwood, C. H. Barney, A. H. Patterson, M.W. Goodyear, Fred. W. Royce, F. O. Gilbert, P. H. Alexander, C. G. Perkins. C. E. Stump, W. A. Kreidler, George H. Neal, Frank Ridlon, A. P. Wright. George W. Adams and others.

As the time for leaving approached a procession, headed by the band and led by Grand Marshal Patterson, was formed and the guests marched away to the steamer landing, fittingly bringing to a close the Clambake of the Year.

The steamer conveyed the party to the "Catskill," which was lying at Hopkins & Pomeroy's wharf, Providence. From thence they went forth to see how much was worth seeing in the busy city, and if one can judge from the late hour of their returning, many of them must have found much to interest them. At nine A. M. Sunday the "Catskill" left for Newport. On passing Mr. Sawyer's summer residence three whistles were given, and in an instant a flag was run up by Mrs. Sawyer, and a farewell salutation was waved from the piazza, and heartily responded to by the passing guests, the band playing the "Star Spangled Banner." The Vue de l'Eau Club was also saluted, and the steamer passed on to the lovely stretch of water, which Mr. Watson, the designer, has declared to be the finest yachting course in the world.

The morning was perfect, bright and sunshiny, tempered by a cooling breeze, and nothing more delightful can be imagined than the trip down the bay, with its endless windings and never ceasing unfolding of nature's panorama. Newport was reached at 11 o'clock, and the programme for the day, which was announced by Gen. Barney, was as perfect as the rest of the arrangements that had been carried out by the efficient committee. An invitation from Commodore Higginson to visit the training ship "New Hampshire," and one from Mr. John Whipple, Jr., Superintendent of the Edison Illuminating Company, could not unfortunately, for want of time, be accepted. The first visit was to the beach, and a number indulged in a surf bath. Sundry of those looking on were picked up by their brethren and carried out, nolens volens, into the sea, and held over the curling waves in perilous uncertainty or gently flopped in, according to the mood of the captors or the behavior of the captured. The striking face of the president of the New York Electric Club took on a new light as he disported in the sea in a curtailed bathing dress and white top hat, and the staid men of science were transformed into a set of rollicking boys, brimming over with mischief and merriment. One highly respected gentleman, hailing from Boston, was walking along the beach with a friend, and remarked how pleased the people looked to see the electrical visitors. As they continued their walk the whole beach began to titter. The broad, benevolent and ecclesiastical face of the gentleman also expanded into a smile as he stated that this was certainly the best tempered crowd he ever *had* seen, and suggested that he and his friend should sit down and also enjoy the fun, whatever it might be. He was soon to know it, for on touching the seat a card with "Milk," in large, staring letters on its surface, which had hitherto lain safely between his broad shoulders, dropped to the ground, and a peal of laughter announced that the riddle had been solved.

The Ocean House was the assembling point, and soon after dinner the entire party, by the kind invitation of Mr. Henry Bull, Jr., proprietor of the Newport Telephone Company, were whirling along the celebrated "Ocean Drive," the charms of which are world renowned. Upon the return the steam launch "Wave" was waiting to taking the party across the harbor to the Torpedo Station, which they had been invited by Commander Goodrich to inspect. They were received by Lieutenant Commander Converse, and were conducted through the electrical laboratory and testing department and the dynamo room by Lieut. C. F. Hutchins. Professor Monroe gave a lucid description of the various experiments that had been made with gun cotton and high explosives, and was listened to with great attention.

The officers did everything in their power to contribute to the entertainment of the party, and the exhibition of the search light made an effective finale to a memorable visit. The steam launch took the party direct to the "Catskill," which left the wharf at 8:30 o'clock for New York, arriving at 9 o'clock Monday morning. It is needless to say that the unequivocal success of the trip was mainly due to the admirable way in which the committee under General Barney discharged the duties they had taken in hand.

Tinning by Simple Immersion.

Argentine is a name given to tin precipitated by galvanic action from its solution. This material is usually obtained by immersing plates of zinc in a solution of tin containing 6 grams (about 90 grains) of the metal to the litre (0.88 quart). In this way the tin scrap can be utilized. To apply the argentine according to M. P. Marino's process, a bath is prepared from argentine and acid tartrate of potash rendered soluble by boric acid. Pyrophosphate of soda, chloride of ammonium, or caustic soda may be substituted for the acid tartrate. The bath being prepared, the objects to be coated are plunged therein, first having been suitably pickled and scoured, and they may be subjected to the action of an electric current. But a simple immersion is enough. The bath must be brought to ebullition, and objects of copper or brass, or such as are coated therewith, may be immersed in it.

Tests of Primary Batteries.

To the Editor of the Electrical World:

SIR: In a communication under the above heading in THE ELECTRICAL WORLD of September 1, mention is made of "The Fitch Perfect Battery," and its performance is elaborately reported on. The figures are no doubt correct, but they have, I think, a tendency to mislead and to create a wrong impression in regard to my battery. I therefore, ask permission to make the following explanations:

The cells described as "Two cells of form (*a*)" were my regular cells of *open circuit* battery, $4 \times 4 \times 6$ inches. They were never intended or recommended for any service requiring such a test. When I sent them I sent also a letter containing the following: "The cells herewith sent as samples are my *regular open circuit cells*, probably too small, hence, not adapted or recommended for regular or practical use on your motor." I was much surprised to find them included in the report.

Many electricians regard as reasonably efficient any open circuit battery in which the E.M.F. falls only .66 per cent after "short circuiting" on a resistance of half an ohm per cell; and very few electricians would take so much trouble to show that batteries of this class will polarize when closed for seventy-two consecutive hours on a resistance of only half an ohm per cell. The fact that they will do so has been abundantly demonstrated in practical service, and needs no technical proof. Some electricians regard it as a desirable feature that batteries of this class should so polarize, and thus save themselves, when accidentally short-circuited. The author seems to have mistaken polarization for exhaustion.

The figures in regard to the "two cells form (*b*)" are no doubt correct for the test as made, but they differ widely from results which I obtain. Theoretically, my excitant will consume about two-fifths of its weight of zinc, and thousands of cells in practical use have proved the correctness of this proportion.

The report shows that "(3 lbs. 6 oz)" = 54 oz. of the excitant was employed in each cell, and the *greatest* actual consumption of zinc was 4.75 oz. in one cell, or less than one-tenth of the weight of the excitant. Hence, only about one fifth of the excitant was consumed in the test. Clearly the cells polarized, and this seems to have been mistaken for exhaustion.

The test shows that the cells were not adapted to service on resistance as low as less than half an ohm per volt, but this by no means proves that they are not well adapted for higher resistance on open circuit service.

CAZENOVIA, N. Y. D. H. FITCH.

Effects of Static Discharges on Incandescent Electric Lamps.

BY CRAIG R. ARNOLD.

The article in THE ELECTRICAL WORLD of Sept. 8 regarding certain actions of incandescent lamps was read with much interest, and having made conclusive experiments in that line, it leads me to give this article for what it is worth to others. I installed a couple of plants in the fall of '86. One was in a cotton mill, and one in a woolen mill, and the lamps in certain positions gave out so rapidly that I determined to make certain experiments to verify the theory proposed, namely static discharges through lamps, which ruin the vacuum.

In the woolen mill the lamps were placed in the centre of four crossed belts to light up the clutches, etc., used in the rooms. These lamps gave out almost every night, and were finally taken out altogether. Last fall the matter was taken up in the laboratory at Sharon Hill, Pa., and tests were made on the dynamo for lighting the above building. The power was transmitted to the dynamo by an endless three-inch belt that was perfectly smooth and had a velocity of 10,000 feet per minute. In the first instance a lamp running normally was placed within six inches of the belt which was crossed for the trials. The lamp was hung on a regular two-wire flexible conductor and was free from grounds.

This lamp lasted exactly fifteen (15) minutes. The experiment was repeated, and the second lamp gave out in the same time.

The third lamp was removed to a distance of 12 inches, and lasted nearly 25 minutes. In the third test the fourth lamp was still further removed a distance of 6 inches, and it lasted nearly an hour. The direction of rotation was reversed and the belt run without crossing. The experiments were repeated, and the lamps not giving out after a long run, it was taken for granted that they would run their guaranteed life.

Immediately after giving out the lamps were examined, and the carbons showed signs of having air present, and when immersed in water and the nipples were broken off, they would not fill with water.

The belt was again crossed, and the experiments were concluded at night without current, and the discharges at a distance of a couple of feet were plainly visible; and when as near as six inches the lamps and filaments were all aglow from the discharges. When grounded they would give off a discharge similar to a small Leyden jar.

By conducting a grounded wire to the point of the lamp, such discharges had no effect on the lamps. Lamps suspended on iron pendants that were grounded and shielded by wire guards were also free from these effects.

Perhaps other readers have had similar experiences and may be able to throw light on the subject. What a good little Christian the incandescent lamp is. Even so small a portion of the outside world is fatal to its existence! As nature abhors a vacuum and the incandescent lamp cannot exist without one, it might seem that even nature was opposed to its existence as well as crossed belts, etc.

Popular Electricity.—A reader in a large Southern city sends us this amusing item: "A clerk in a large dry goods store recently explained to me the object of the three wires of the Edison system, with which the building was equipped; one was for the positive current and one for the negative, while the third collected all the stray electricity and carried it back to the station."

Whitestown, N. Y.—The Whitesboro Electric Light and Power Company, of Whitestown, Oneida County, N. Y., has been incorporated, with a capital stock of $5,000, to manufacture and furnish electricity for light, power and other purposes. The trustees are: John W. Boyle, Charles E. Smith, James Stephenson, Charles S. Foster, Willard C. Aldridge, D. E. Crain and R. A. Jones.

Photographs of Lightning Flashes.

In the last number of the *Comptes Rendus* M. Ch. Moussette has a short note on the precautions which it is necessary to take when photographing lightning flashes. According to the author, most of the peculiarities noticed in photographs of this description arise from accidental vibrations caused by the wind, the thunder, or the shaking of the earth. In order to prove this, M. Moussette made a white on black drawing of flashes inclined at different angles. This drawing was photographed in two ways: firstly, with the camera carefully secured from vibration; secondly, with the camera slightly jerked at the moment of photographing. In the first case the flashes came out fine and clearly defined; in the second case the flashes presented the appearance of striated ribbons, except where the lines of the drawing were parallel to the direction of motion of the camera.

Artillery Practice against Electric Light Projectors.

A correspondent of the London *Times*, writing from Okehampton, says: "Some interesting experiments have been made here lately in firing at night against the reflector of an electric light. On the first night the range was ascertained, or thought to be ascertained, to be 1,680 yards, and 16 rounds of shrapnel were fired, with the result that only one bullet pierced the reflector. The following day the range was found to be 1,580 yards, but the following night the observation gave again 1,680 yards. That night, accepting the daylight observation of 1,580 yards as correct, 16 shrapnel shells were fired, with the result that six bullets pierced the reflector, which, however, was practically not the least damaged. The artillery officers are unable to explain the fixed difference between the day and night observations of the distance. Had a shell struck the reflector before bursting complete destruction would, of course, have ensued." The engine and dynamo for these experiments were placed underground.

Meridian, Miss.—E. J. O'Bierne has formed the Thomson-Houston Electric Light and Power Company of Meridian, capital stock $15,000, to erect the plant. A site is being looked for. R. P. Williams and others are interested. The plant is to be ready in 90 days.

Merced, Cal.—The new electric light plant at Merced, Cal., will use the Heisler incandescent system. The plant will start in a few days. It comprises a dynamo of 250 lights of 30 c. p., a 50 h. p. Ball engine and a 60 h. p. portable boiler. Mr. A. C. Twain is the superintendent.

Shallenberger's Alternating Current Meter.

In our issue of Aug. 25 we described the new meter designed by Mr. O. B. Shallenberger, the electrician of the Westinghouse Electric Company, and we now give some additional particulars regarding it, for which, with the illustrations, we are indebted to our excellent contemporary, *The Electrical Engineer*. The engraving, Fig. 1, shows the meter as actually constructed, with the case removed, exposing the interior.

The working or motive parts of the meter will be understood from the diagram, Fig. 2. There *a* is a flat ring of soft wrought iron mounted on a light disc of brass or aluminum, and rigidly attached to a slender steel shaft; *b b* are copper plates bunched in the form of a flattened oval and riveted together at the ends, placed so as to surround the disc closely without touching it. These are adjustable in position with respect to the coil *c c*, which surrounds the whole. When in the position shown, the rotation of the disc is in the direction of the arrows, and the torque is greatest when the plane of the coil shown by the line *d d'* is at an angle of 45 degrees to that of the coil *c c*. If while the current is passing through the coil the position of the plates *b b* is changed gradually to *e e'*, the speed of rotation of the disc diminishes until an angle of 90 degrees is reached, and beyond this the direction of rotation reverses, reaching maximum speed again at 45 degrees on the opposite side.

In applying this to the meter only a few degrees movement of the secondary conductors *b b* is required for the necessary adjustment.

This arrangement was selected from a large number of others because of its ease of construction, the small self-induction it introduces, and its ease of adjustment.

The maximum torque is exhibited at an angle between the coils of 45 degrees, while at 0 degrees and 90 degrees it disappears altogether. When the angle is 0 degrees the coils, being parallel, have a maximum mutual induction, but no torque is exerted; and at 90 degrees no current is induced in the secondary coil, and consequently there can be no torque in that position.

The rotations of the disc are counted by a train of wheels connected with an indicator similar to that used for gas meters, and showing ampère-hours. The accuracy of the instrument is affected slightly by changes in the rate of alternation of the current; but since in practical electric lighting the rate of alternation is maintained nearly constant, the error due to this cause is quite insignificant, being less than proportional to the number of alternations. The adjustment to the exact speed required is made by changing the angle of the secondary coil; but in practice the instrument is made very nearly correct as it leaves the factory, requiring only slight correction.

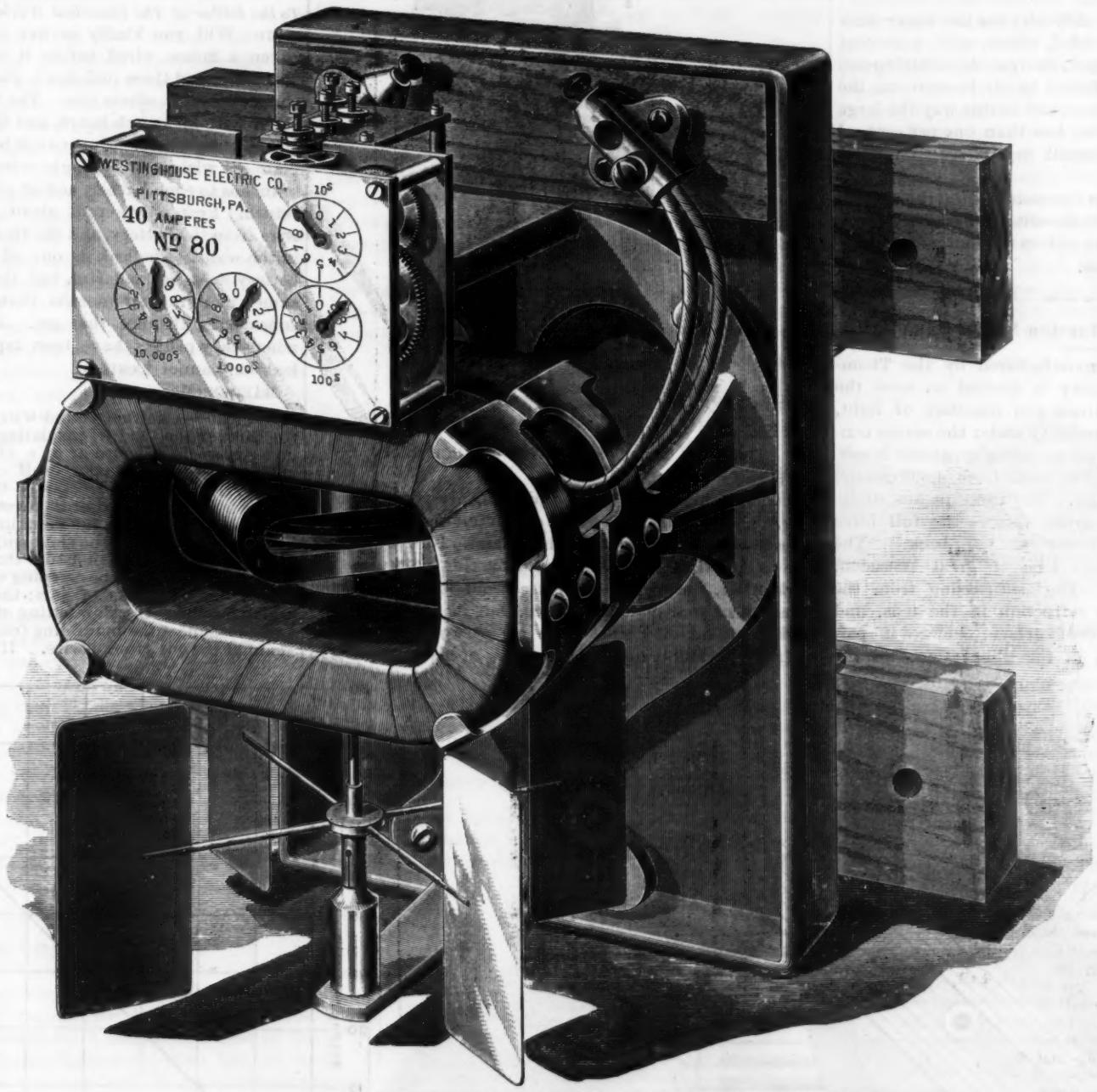


FIG. 1.—SHALLENBERGER'S ALTERNATING CURRENT METER.

TEST OF 40-AMPÈRE METER.

Current in ampères.	Reading of meter.	Percentage of error.
2.06	1.6	....
4.02	4.07	+1.2
5.00	4.95	—1.0
9.9	10.02	+1.2
15.0	15.1	+0.7
20.0	20.0	0.0
29.7	30.0	+1.0
37.4	37.0	—1.1
	Overloaded.	
49.3	45.4	—7.9

The accompanying diagram, Fig. 3, and table show the operation of a 40-ampère meter, with currents varying from the smallest capable of turning the vanes and overcoming the slight friction of the bearings, to an overload of 25 per cent. Currents are measured on the horizontal line, and the corresponding readings of the meter are shown by the vertical distances. It will be seen that the departure from the theoretical straight line representing the mean performance of the meter is very slight, and in no case within the working limits reaches 2 per cent., ex-

cept at the starting point; while at 25 per cent. overload the proportional rate only falls off 7.9 per cent.

The ease with which this meter may be adapted to circuits of different capacity is obvious. By interposing between the meter and the circuit to be measured a small converter, the current may be reduced or increased in any ratio, and since the energy transformed by such converter is only the amount required in operating the meter, namely, about one-eighth of one per cent. of the energy measured, the dimensions of the converter may be very small, and consequently but very little is added to the cost of the simple meter. By changing the ratio of this converter any capacity may be given to the meter, so that the same instrument may be used to measure ten lights or 10,000 lights within the same percentage of accuracy and without change in its construction.

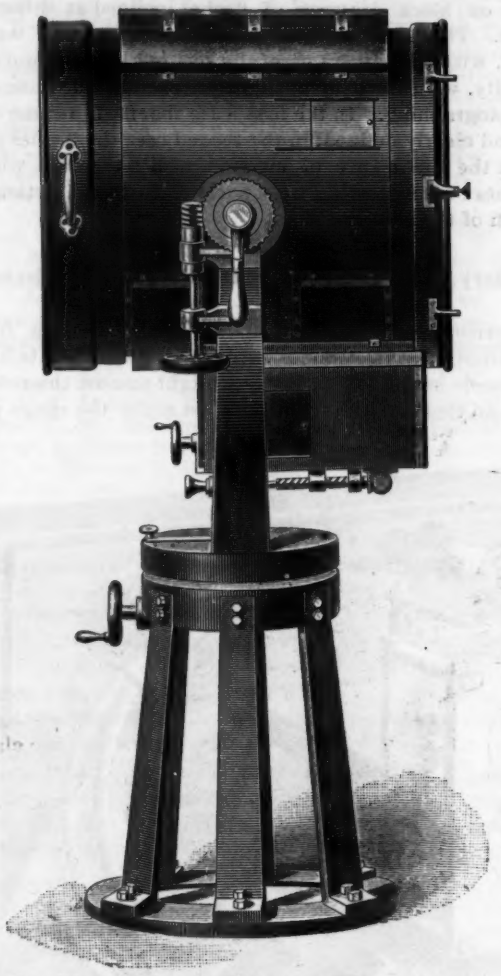
There is, however, one feature worthy of notice in this connection, namely, the point at which the meter will begin to turn, or in other words, the percentage of its full load at which the registering of the current begins. This, in the 40-ampère meter already mentioned, is 1¼ ampères, or say three per cent. of the rated capacity. While this represents only one or two lamps on a 40-ampère meter, and only one lamp on a 20 ampère meter, it will be seen at once that on a meter for 1,000 lamps the same proportion would give 30 lights required to start the counter.

In order to overcome this difficulty for the larger sizes of meters a shunt coil is provided, which, with a current almost inappreciable in amount, charges the inducing coil of the meter to a degree sufficient barely to overcome the inertia and friction of the vanes, and in this way the large meter may be made to start on less than one per cent. of its full load as easily as the small meters start on three per cent.

Practical tests have shown the meter to be thoroughly reliable in its action, and with the exception of some minor details in the construction, no serious difficulties have presented themselves at any time.

The New Thomson-Houston Search Lamp.

The new naval projector manufactured by the Thomson-Houston Electric Company is devised to meet the prime requirements of steadiness and intensity of light, ease of manipulation and durability under the severe conditions of weather to which all sea-going apparatus is subjected. The arc lamp, which is made from 4,000 candle-power upward, is fed by hand. The carbons are so inclined that the "crater" carbon throws the full force of the light to the reflector at the back. The reflector is a concavo-convex lens of great precision, silvered on its back surface. The light passing from the arc at the focus undergoes refraction in the lens, and being reflected from the silvered surface, emerges in parallel rays. As will be seen in the illustration, all the wheels and handles for controlling the direction and feed of the projector are situated so that the operator may station himself directly behind the lamp and work without changing his position, This naval projector, by reason of its great power and accurate adjustment, is especially adapted for use on ships of war. The Thomson-Houston Company, however, manufacture a different type of search lamp, suited to all the needs of the merchant marine, and also a small size for steam yachts. Few steam vessels now are built and sent to sea without such electric search lights.



THE NEW THOMSON-HOUSTON SEARCH LAMP.

To Unhitch Horses.—The Columbia Electrical Company, of Portland, has been incorporated by P. F. Morey and others with a capital stock of $25,000, to manufacture apparatus for unhitching horses electrically in case of fire, etc.

The Shape and Size of Armatures.

To the Editor of The Electrical World:

SIR: On June 30 Mr. Cecil P. Poole made some assertions about sizes of Gramme armatures, and on June 21 I took exception to his claim of being the first to set out the proportions of the armatures for given output of machines, calling attention to the fact that such data were set out in Mr. Carl Hering's excellent work, "Principles of Dynamo-Electric Machines," which you publish. In your issue of Aug. 18, Mr. Poole, with his characteristic superiority, takes me to task for doubting his claim. Now I do not care to enter into any discussion upon this point, as the work of Mr. Hering shows for itself, nor do I wish to take up much of your valuable space; but in justice to Mr. Hering and myself I must make one or two remarks.

Mr. Poole doubts my understanding of his statements in the June 30 issue, but I assure him that I fully understand his intended claims, and in my judgment consider that the descriptions of the construction, shape, etc., given in Mr. Hering's work, is not only a clear statement of what governs the shape and size of armatures for a given output, but is based upon sound facts and not "guessed" at. It is simply unreasonable for Mr. Poole to give a fixed relative proportion between length and radial thickness of the armature core up to a given output, and above that output to give an entirely different relative proportion, and call that a rule approaching anything near accuracy. Theoretically the relation should vary with every change in output. Mr. Poole's rule (?) is empirical and unreliable, whereas Mr. Hering, like an electrician, lays down his rules as near as they can be laid down, and does not ask the public to "go it blind." It is also to be noticed that in the answer of Mr. Poole to my letter of June 21, he claims to have read every page of Mr. Hering's work, but he does not say that he read it until after the 21st day of June.

I believe in giving credit to him to whom it is due. Beyond this I have nothing further to say, as Mr. Hering's book speaks for itself, at least to electricians.

PHILADELPHIA. R. M. HUNTER, M. E.

Hughes on Self-Induction.

To the Editor of the Electrical World.

SIR: Can you kindly inform me where I can obtain a lecture or paper by Professor Hughes on self-induction?

H. N. MARVIN.

SYRACUSE, N. Y.

ANSWER.—Both of the most recent researches of Professor Hughes on this subject are described in papers published in this journal. These are: (1) "The Self-Induction of an Electric Current in Relation to the Nature and Form of its Conductor," published in THE ELECTRICAL WORLD, Feb. 27, March 6, 13, 20 and 27, 1886, and (2) "Researches Upon the Self-Induction of an Electric Current," in THE ELECTRICAL WORLD, July 3, 10, 17 and 24, 1886.—EDS. E. W.

Locating Troubles of Electric Gas Lighting Circuits.

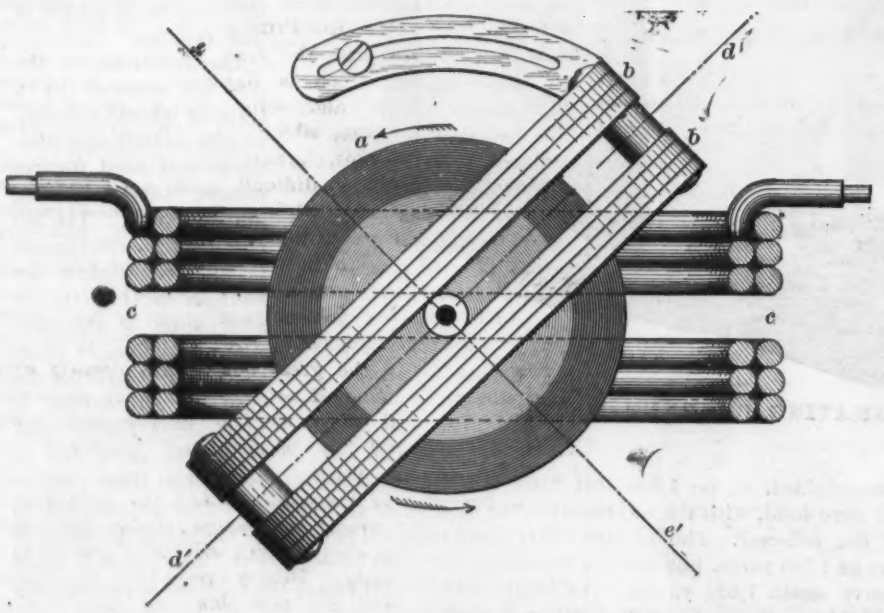
To the Editor of The Electrical World:

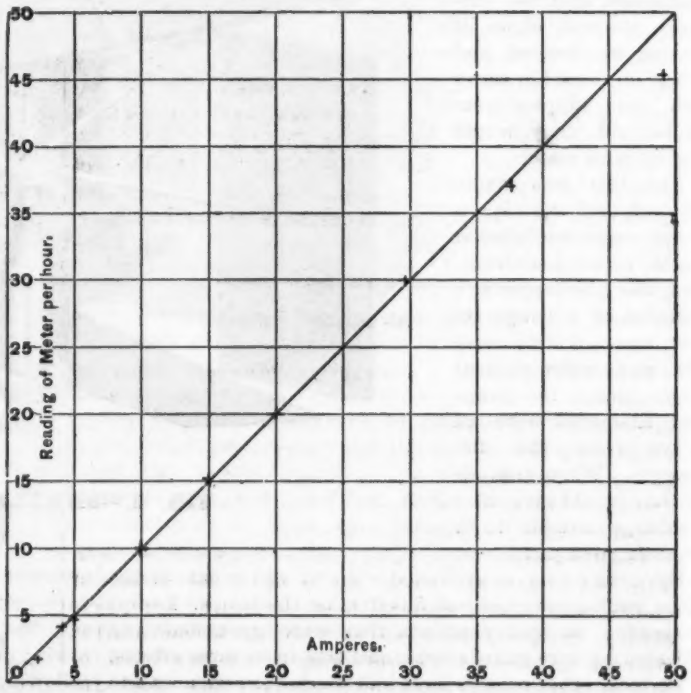
SIR: Will you kindly answer the following question: Given a house, wired before it was plastered with one automatic and three pull-down electric gas lighters, with connections for others also. The battery is located in the cellar with no switch-board, and there is a ground on the circuit somewhere. How can it be located easiest? The plan of wiring is a single wire from battery which branches to each burner, and of course uses gas-pipe for return. I can only get at about the first ten feet of the wire from the battery, and the tips of the projecting wires in the walls. The leak is one of high resistance, as the battery does not polarize, but the zincs have been consumed more in four months than is usual in two years, considering the use they get. All the ends of the wire where they project have been tapped. I know there is a leak but cannot locate it. ELECTRO.

MALDEN, Mass.

ANSWER.—Cut the ground-wire and apply the ends of the same to the tongue, insulating the body by standing on a dry piece of board or on a chair; then if the circuit is grounded it will make itself clearly apparent to the taste. If no taste is perceptible then the line is clear; if on the contrary a current is present, then there is a leak to ground either from the main lines or from the battery, or both. Frequently the shelf supporting the battery becomes saturated with moisture through the filling of the jars with water and the creeping of the sal ammoniac and salts down the sides of jars; this makes a poor ground which produces the slow eating of zincs mentioned. To test, disconnect the main line from the battery and taste again at the cut ground-wire. If a leak is tasted, it may be corrected by cleaning and drying the exterior of the glass jars and putting a fresh dry board under them.

If the leak is on the circuit wires, it should be first located on a floor by cutting the main rising wire where it passes upward behind pocket for sliding doors on the parlor floor, or behind basins in toilet-rooms on floors above. Having located the trouble on the floor, remove all fixtures and clear the outlet branches where they pass out alongside of the gas-pipe into the room, by digging out the plaster around them, so that they are entirely free and may be worked in and out by the hand; the holes made in digging free will be hidden by the back-plate of the fixtures. If this does not clear the fault then the pockets must be taken up over each chandelier and at the floor under each bracket (particularly in the last case where wires have been plastered in dead walls to side-brackets), the branch wires cut, and the test made if ground has been cleared. It is most probable from your statement of the case that the leak (if one exists) is at the battery.—EDS. E. W.





FIGS. 2 AND 3.—SHALLENBERGER'S ALTERNATING CURRENT METER.

The Electricity of Animal Organisms.

BY R. M. HUNTER, M. E.

In THE ELECTRICAL WORLD of Aug. 25, 1888, under the title of "On the Relation between Animal Electricity and Surface Tension," I find the statement: "There will thus be explained its high rate of efficiency, the heat being the residual product of the muscular contraction and not the source of that contraction." This remark was made in showing that the muscles acted rather as an electric motor than as a thermic motor. The thermic motor theory has not been generally held for many years past, the electric motor theory having been before the public for a long time; and hence the surface tension theory, while disclosing certain facts upholding the electric motor theory of the muscular action, nevertheless is not that which brought it out. The quotation made would imply that the heat of the body was due to this surface tension action.

In my study of the subject of animal electricity I have found that if the flow of blood through the veins, arteries and capillary plexus is arrested, the muscular contractions and all nervous sensations are extinct, and further that the heat will be sustained so long as the ozone of the blood in that organism is not being converted into carbonic acid by chemical combination. After that, the part becomes cold.

If now, blood is allowed to flow through the veins and arteries its vitalizing properties are made apparent and the combination of the oxygen of the blood with the carbon of the organic tissues immediately takes place and performs two results, viz., it brings back the warmth, and also the life or power to muscular contraction. The electricity and the heat are generated simultaneously and at *all* times during the life of an animal organism. When an electrical impulse is conveyed to the muscle by the nerve, muscular contraction instantly takes place, and this consumes energy previously generated when the muscle was out of activity.

As a result of this muscular contraction the protoplasm undergoes decomposition, its carbon element combining with oxygen of the blood (upon relaxation of the muscle or change of tension) and forms carbonic acid, which is ultimately conveyed by the blood to the lungs and exhaled, and also generates additional electricity to supply that lost in energizing the muscle. From this it is seen that heat must exist before muscular contraction can take place, and that while it is not the direct cause of the muscular contractions, as in the thermic theory, it is not the "residual product" of the nervo-muscular contraction.

It is true that the muscular contraction necessitates a further generation of electricity and resulting heat to supply the system or organism with energy to compensate for that consumed and keep up the balance. In this case also it is not a residual product, but rather a new generation due to the presence of the vitalizing oxygen in the blood. The resulting or "residual" product from the muscular contraction is the degeneration of the fatty tissues, and their susceptibility to conversion by the vitalizing element of the blood into other conditions capable of generating heat and electricity.

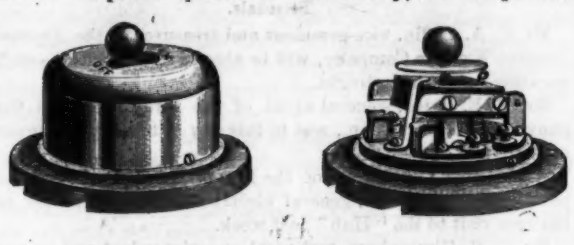
I have not gone into the deeper theory of the subject upon which I base my opinions, but the few remarks made may set others to the investigation of this most useful and interesting subject.

The New "Dynamic" Switch.

It is well known that some of the insurance rules for incandescent lighting require the use of double pole switches for all currents above 5 ampères. Some of the members of the late electric light convention had an opportunity to examine the new switch of the Hartford Dynamic Company, of Hartford, Conn., which is illustrated in the accompanying engravings.

The illustration, Figs. 1 and 2, shows its appearance both with and without the cover, and most of the details of construction. The upright bent lever which projects through the cover and serves as a handle, is connected at the back end through a spiral spring to a tilting block of hard rubber or other insulating material. This block carries the movable portions of the metallic circuit, as shown in the cut. When in the act of closing the circuit, the spring is stretched, when breaking it is compressed; but as soon as the hand is removed the lever moves slightly till the spring is in equilibri um; being then of its natural length, it should maintain its elasticity unchanged. But although the lever can be moved slightly by the spring the block cannot be moved so as to make the contracts uncertain. The block is effectually locked in position, either open or closed, and cannot be moved to the other position except through the use of the lever or a force great enough to break the switch. This ingenious locking device consists of two pins in the block working around a four-sided steel lug in the lever. Assuming the switch "off," and the circuit open, as the lever is drawn upward the spring is stretched, but the block cannot move until the lever has gone far enough to allow the pins to slip off from the lug; by this time the spring has been stretched to its utmost and the side bars are carried down firmly into the jaws. t is impossible for these contacts to separate by a rebound of the parts, for the pins and lug prevent this; nor by carrying the lever too far, for this keeps up the tension on the spring until the hand is removed. Similarly if the switch is "on," the movement of the lever first compresses the spring, and then releases the locking mechanism so that the block flies up and opens the circuit.

The illustration further shows that the jaws for contact are quite short. This is considered a decided advantage to the user, for the fitting must be accurately done or it would not pass inspection at the factory, and the jaws are much less likely to get bent out of shape in handling or use.

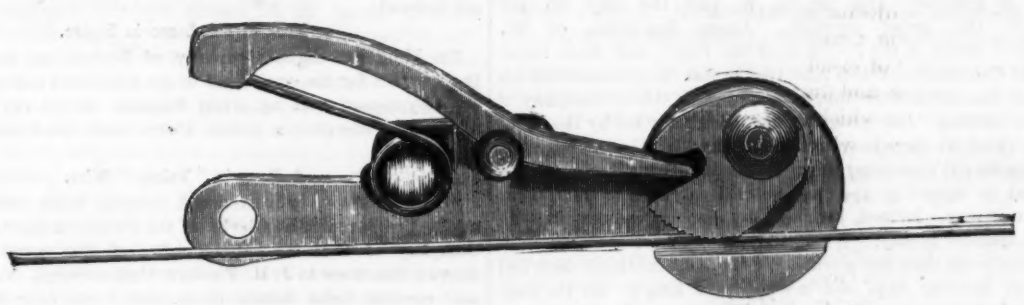


FIGS. 1 AND 2.—NEW "DYNAMIC" SWITCH.

The cover is of a tasteful shape, with rounded shoulders instead of square, and nickel-plated, and the dust-cap prevents trouble from dust and insects. The lettering shows at once whether the current is "on" or "off," although the lights may not be visible.

New Automatic "Come-Along" for Linemen.

Our illustration represents a new automatic "come-along" now being introduced by the Central Electric Company, of Chicago, and which is so simple as to hardly require detailed explanation. As will be seen, it consists of a lever which, by means of a spring, is pressed against a toothed cam that grips the wire inserted in the clamping jaws. The arrangement is such evidently that merely placing the wire between the jaws and pulling serves to grip the wire firmly, and the stronger the pull the more powerful the grip. When fixed in position, the wire is at once released by pressing against the spring lever, which raises the cam clear of the wire. As no screws and nuts are required, considerable time and trouble are saved.



IMPROVED "COME-ALONG" FOR LINEMEN.

The Baxter One-Quarter Horse-Power Motor.

The quarter horse-power motor shown in our cut has within the last few months been placed upon the market by the Baxter Electric Motor Company to satisfy the demand for a strong and durable motor which shall fill the requisites of a high class machine. Special attention has been given every detail to insure ample strength and durability of all parts which receive the wear and tear of even the roughest usage.

BAXTER ONE-QUARTER HORSE-POWER MOTOR.

The motor is constructed for constant current circuits, with provision for adjusting the speed by hand or treadle attachment to the ring projecting in front of the name plate. By a simple movement of this ring, power and speed may be varied at will. This motor is intended for the running of fans, small pumps, or similar machines where the load is constant and regulation is not required; but the company proposes in the near future, for the driving of light machinery where a nicety of regulation is desired, to furnish a motor of this size which shall govern automatically. The shaft is of hardened steel, ground and finished to gauge, and runs in cast-iron bushed self-lubricating bearings, which for long periods require no attention. The commutator is of such material as to resist all wear and cutting of its surface, and is one of the noticeable features of the machine. The motor is compact and ornamental in appearance, and is substantially constructed and proportioned throughout, and the efficiency is high.

The Electric Light in Paris.

It is often said that there is no electric lighting in Paris. A correspondent of the London *Electrical Review* writes however as follows:

The use of electricity in everyday life in Paris is becoming more and more manifest, whilst the city is flooded with books and pamphlets on electricity.

However, the chief question of the day here, as regards electricity, is the lighting of the principal thoroughfares by electric light. Nobody doubts for a moment that this will soon be effected, but the great stumbling block is the City Gas Company, which is working tooth and nail to resist the innovation. Its losses have already been considerable, and the directors are doing all in their power to retain custom by constantly lowering the price of gas, and even—which is not generally the case here—laying the pipes in dwellings free of charge. The gas company tried, too, to obtain the working of the electric station contemplated to be established by the city corporation, but that affair failed.

The public, as well as the authorities, who were at one time rather sceptical as to the electric light, are now gradually coming round, and begin to realize its advantages, as, for instance, the little or no danger as regards fire, its pleasantness to the eye and lungs, and its decorative effect. To this the terrible fire at the Opera Comique has no doubt contributed, as well as the heat and smell of gas generally prevailing in Paris theatres and shops. Consequently, extensive electrical plants have been introduced into the Bon Marché, the Louvre, the Printemps, as well as several theatres. Of the latter, the most extensive is that of the Grand Opera, which is lighted by 7,000 incandescent lamps inside, and some arc lamps in front. The installation here, which was effected under the guidance of Mr. Vernes, the managing director of the Edison Company, was very difficult, as the space hardly sufficed for the machinery, while at the same time the wires had to be laid contiguous to the gas pipes. In fact, in all new public buildings to be erected, regard should be paid to the eventual introduction of the electric light.

In order to see the present application of the electric light in Paris more generally, one need only take a walk any evening along the great boulevards. Nearly every café, theatre or shop of note is lighted by electricity. In the cafés and shops electric incandescent lamps, sometimes colored or shaded and gathered into tasteful bouquets, throw a beautiful light upon the objects displayed in the windows and the pavement in front, while the strong arc lamps outside are hardly less effective. The shops which still burn gas are in an insignificant minority. Nearly everywhere the electric light is encountered, and new plants are daily laid out. Even working tailors and bootmakers who are obliged to have a gas motor in use on their premises, apply it to a dynamo for electric lighting at night. Naturally in the larger factories and mills the electric light is already introduced, as a matter of course, and in the great tailoring establishment La belle Jardinière, all the sewing machines in the upper stories are worked by means of a powerful generator in the basement, which also supplies the electric light. It must therefore be said that the electric light is making remarkable progress in this city of gaiety.

Sea Isle City, N. J.—At Sea Isle City, N. J., a few days ago, the president of the Electric Light Company refused to pay the contractor who erected the company's building the last installment on his contract. The contractor, with a body of men, seized the works and shut off the lights from the whole place. Then the Mayor and counsel for the company with a posse recovered the works, and started the lights again, and the whole matter will go before the courts.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
168-177 POTTER BUILDING, NEW YORK, Sept. 6, 1888.

The Fire Department Cables.

Mr. G. L. Wiley, the manager of the Eastern sales department of the Standard Underground Cable Company, reports that his company has just been awarded a contract for one million and eight thousand feet of cable, to be placed underground in New York City for the City Fire Department, which already has a million feet of the same cable in active service.

The Standard Rocking Grate Bar.

The National Iron Works of New Brunswick, N. J., have been unable to close their works, even for a day, to take account of stock, as is usual at this time of the year, on account of being very busy in their various departments, especially the filling of orders for the Standard Rocking Grate Bar, which has now been in successful use about four years, under heavy fires night and day. It has only lately been placed on the general market, as the manufacturers decided to give it a severe test before generally introducing it on its merits. It has now passed the experimental stage, being pronounced a success by all parties using it.

The Fulton Street Electric Road.

I take the subjoined from the *Commercial Advertiser:*

Fulton street, from river to river, has been encumbered for many months with railroad tracks which are not used; neither does the city derive any revenue from the franchise under which they were laid. The tracks were put down by the North and East River Railroad Company, which intends to run its cars by electricity. The project was brought to a standstill because other street car companies refused to allow the North and East River Railroad Company to use their tracks, which were needed to complete its circuit. The company appealed to the last legislature for a law compelling the other companies to grant the use of their tracks, but the bill was not acted on. General Newton was asked to-day if the Department of Public Works could remove the unused tracks. He replied that while the tracks were clearly an obstruction to public travel, they had been placed in the street legally and could not be removed unless it was proven that the company was dead. Deputy Comptroller Storrs said that the company had three years in which to construct the road, the franchise for which was bought on May 31, 1887. The company at that time gave a bond of $10,000, and agreed to pay the city 35 per cent. of the gross receipts. Aaron Raymond, of No. 131 Fulton street, is the president of the North and East River Railroad Company. When told that it was understood that his company was defunct he laughed and said: "Our company is alive and kicking. Our progress has been retarded by the negotiations which we have been carrying on with other roads over whose tracks our cars must pass. I think that we have at last succeeded in agreeing upon an equitable amount to be paid for the right of way. Indeed, I expect to sign an agreement with these companies to-day. When that is done we shall be in a position to go on with the work. We shall establish an electrical station at Burling Slip, and it wont take long to lay the electrical conduits between the tracks. We can make money and pay a handsome dividend. The cost of running the road by electricity will be a great deal less than if we used horses."

Subway Matters.

The Board of Electrical Control has asked the Board of Aldermen to pass an ordinance requiring the removal of all poles and wires which do not comply with the rules and regulations of the Board of Electrical Control. It called attention to the death of the boy Witte and of the peddler Stiffer, and said that they were caused by infractions of the rules of the board. It charged that the United States Illuminating Company is an old offender, having persistently refused to use the subways. Mr. Eugene T. Lynch, of the United States Company, sent a paper replying to this communication of the Board of Electrical Control. He charged that the board is run in the interest of the Subway Company, a private corporation, and that the subways themselves are small iron pipes full of moisture, and only open at the ends of block lengths. In closing he said: "We are powerless ourselves to open the streets. The Subway Commissioners refuse to allow the conduits to be tapped or touched anywhere except at the manholes at the ends of the blocks, and they have failed to lay down any subway to which the electric light wires can be carried and distributed to the different points required for lighting." Mr. Lynch also charged that the Board of Electrical Control favors the Mount Morris, the East River and the Harlem Company to the prejudice of the United States. Both communications were referred by the Aldermen to the Committee on Lamps and Gas.

Sprague Items.

I learn that Mr. Frank J. Sprague has consented to deliver a lecture before the Franklin Institute of Philadelphia, during the winter, upon the Far Transmission of Power by Electricity, a subject he is sure to handle to advantage. The recent installations for mining work at Big Bend, California, and at Aspen, Colorado, illustrate two different problems of this nature, which have been successfully solved by the Sprague Company. At Big Bend, there are fourteen stations which are supplied by electricity from a constant potential circuit over eighteen miles in length. These are used for pumping, hoisting, hauling, and all kinds of mining operations. At Aspen, Colorado, two electric mining hoists, used for doing all the hoisting and hauling work at the Veteran Tunnel, in Aspen, are supplied by power from a Pelton water-wheel, situated over a mile away. W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
178 Devonshire Street, Boston, Sept. 5, 1888.

Thomson-Houston Business Abroad.

The frequency of late of gentlemen going abroad in the interests of the Thomson-Houston International Electric Company is attracting a good deal of attention. It is another evidence of the growing demand abroad for the company's systems of electric lighting. Mr. C. L. Mansfield starts for Guatemala in a few days, and will have charge of the installation of several Thomson-Houston plants in various sections of Central America. Mr. G. F. Mathews has just sailed for the Isthmus, and will locate at Colon (U. S. of Colombia), where he will take charge of the local electric light station, using the Thomson-Houston system. Mr. C. W. Grant, who has previously been in charge of the Colon electric light station, is to be transferred to the City of Panama, where he will look after the installation of a new station, which will be equipped with the Thomson-Houston arc and incandescent systems.

Personals.

Mr. C. A. Coffin, vice-president and treasurer of the Thomson-Houston Electric Company, will be absent from the city—on his vacation—about a fortnight.

Mr. M. E. Baird, general agent of the Eddy Electrical Company, of Windsor, Conn., was in this city last week, and favored me with a visit.

Mr. Thomas C. Perkins, of the firm of T. C. Perkins & Company, Hartford, Conn., general electrical contractors, was on a business visit to the "Hub" last week.

Mr. C. H. Gimingham, technical superintendent and manager of the Edison-Swan Electric Company, of England, accompanied by his wife, is making a pleasure trip through the United States, and spent a few days in Boston last week prior to his start for the West.

New Engine for Marine Work.

The Armington & Sims Engine Company has favored me with a photograph of its new special double engine. The photo shows the engine driving a Brush dynamo with gears, and it presents a very attractive picture. It was taken from a plant recently furnished the U. S. S. cruiser "Boston."

The company has in progress of construction for the Navy Department several of these special double engines, each of which will be coupled direct to the dynamo with flexible coupling. This is undoubtedly a desirable arangement for marine work, as only a small space is required, and the combined weight of the engine and dynamo is very moderate.

The Eddy Motor.

The handsome and serviceable electric motor manufactured by the Eddy Electrical Company, of Windsor, Conn., is finding a ready sale, and has already acquired an enviable reputation throughout the New England and Eastern States. Messrs. T. F. Hunter & Company's (of New York) New England Agency at No. 65 Oliver street, Boston, is pushing the sale of the Eddy motor in this section. Several motors have been sold and orders for more are in hand.

More Signal Boxes in Boston.

The Municipal Signal Company, of Boston, has been awarded the contract for the equipment of six additional police divisions in the city named, making, when finished, twelve divisions in all using the company's police alarm and inter-communication system.

A Boom in "Vulcan" Wire.

"Vulcan" wire is in demand, judging from evidence shown me by Treasurer F. E. Clark, of the Campbell Electrical Supply Company of Boston. Fifteen miles of this popular wire was shipped last week to J. H. Findlay, Ogdensburgh, N. Y., for the new electric light station there, and it was only of recent date that fifteen miles of "Vulcan" wire was furnished the new electric light station at Great Falls, N. H. (owned by the Dover, N. H., Electric Light Company); and 18 miles of the same product was furnished about the same time to the Danvers (Mass.) Electric Light Company.

The Police Department of the City of Boston has purchased to date upwards of 100 miles of "Vulcan" wire for use on its police signal system.

Sawyer-Man Interests Thriving.

Through the courtesy of Messrs. Chapman and Carey, of the New England office, in Boston, of the Sawyer-Man Company, I learned to-day that this company had recently installed the following isolated plants, viz: 300 incandescent lights at the factory of the Forestdale Manufacturing Company, Forestdale, R. I.; 250 lights at the Jaffrey Mills, Jaffrey, N. H.; 100 lights at the mills of the Saxon Worsted Company, Franklin, Mass.; 100 lights for Mr. Thomas A. Watson, at Weymouth, Mass., and 150 lights for Messrs. Perry, Mason & Co., Boston, Mass.

Reflectors for Electric Lights.

This useful line of goods as manufactured by the Wheeler Reflector Company, of Boston, is receiving justly merited attention and appreciation from most of the electric light manufacturing companies. By the use of the Wheeler reflectors the efficiency of the incandescent or arc light is greatly increased, and is concentrated where most needed, making the light uniform and economical. This reflector is, of course, more especially adapted for the incandescent light; and for office or domestic service its usefulness would be demonstrated as soon as tried. Electric light companies should recommend to customers the Wheeler reflector.

Thomson-Houston Plants.

The Thomson-Houston Electric Company report the following increases: Youngstown, Ohio, 35 arc; Augusta, Ga., 100 arc; Pittsfield, Mass., 30 arc; Norfolk, Va., 100 arc; New York City, 100 arc, 500 alt; and the following new plants: Plymouth, Mass., 60 arc, 500 alt.; Gt. Falls and Rochester, N. Y., 200 arc.

Another Electric Street Railway.

A special dispatch to the Boston *Record* under date of Aug. 20 reports that a Watertown, Mass., gentleman states that he and other parties have decided to build an electric street railway, using the overhead system, between Watertown and Waltham. An application for location will be made as soon as the surveys are completed and other details arranged. The line will be three miles long, cost complete with rolling stock $40,000 and be built this fall or early next spring.

More Wires Down East.

To the Boston *Globe* I am indebted for the following Portland item which appeared in the columns of that paper under the above heading: The Commercial Union Telegraph Company, running in connection with the Postal and United Lines systems, will open here for business to-morrow. This company has fitted up the handsomest office that any opposition company ever put in here, and have a first-class district system of 10 miles of wire and 300 call boxes. A quadruplex will be in operation with Boston in a week's time. The sympathy of the public is with them, and a handsome business is sure to follow, Portland business men being partial to opposition telegraph companies. F. Scott Smith, for many years manager of the Mutual Union Telegraph Company of Boston, and at one time a member of the *Globe's* editorial staff, has been appointed Superintendent of the new lines, which run from Albany to Portland, and he guarantees nothing but the best of services for all parties. The new line has branch offices in Lowell, Lawrence, Haverhill, Exeter, Dover, Kingston, Biddeford, Saco and Old Orchard. W. I. B.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
39 South Tenth Street, Philadelphia, Pa., Sept. 5, 1888.

J. W. Queen & Co.

Messrs. J. W. Queen & Co., the well-known opticians and dealers in electrical instruments, have leased the premises at No. 927 Chestnut street, directly across the way from their old stand, and will occupy them until the alterations now being made to their building shall have been completed.

An Edison Boat.

Mr. Thomas A. Edison will, it is reported, shortly have a 60-foot boat built here, to be propelled by his improved patent electric marine engine.

Electric Roads.

From present appearances it is not unlikely that the management of the Lombard and South Streets Railway will shortly substitute electricty for horse power on its lines. Negotiations are now pending with the manufacturers to build ten electric cars, but the contracts have not been formally made, as the cost is as yet undetermined, and one or two minor matters are unsettled. Should the negotiations terminate satisfactorily, as is expected by both parties, the Lombard and South Streets Company will withdraw its horse cars entirely from the line in the old city. For the present, however, horses will be used on the West Philadelphia end. Since the electric motor car has been running a careful record of the cost of maintaining it and its capacity to handle business has been kept. Allowing for the original cost of horses, their keep, and making allowance for depreciation in their value, it is ascertained that the cost of motive power for the electric car is a little less than half the cost of horse power. The Wharton car will be used on this line, as also on the new Lehigh avenue road, which is now completed as far as track-laying is concerned, but has not yet been operated.

Pittsburgh, Pa.

The Fort Wayne Jenney Electric Light Company have erected a tower on the new Carnegie Library property, Allegheny, Pa., and are giving an exhibition of their tower system of lighting. The contract for lighting the city of Allegheny has not been given out yet.

An electric light plant is being installed at Beaver Falls, Pa., in the old Cutlery building owned by the Economites. Water power will be used.

The electric street railway connecting Rochester, Beaver, Vanport and Bridgewater is still in its infancy. The contract has not been let yet. John Conway & Co., Rochester, Pa., are interested.

It is reported that an electric road will be built from Bellevue, Pa., to Allegheny, a distance of six miles. A meeting of the most prominent citizens and property holders of Bellevue was held a few evenings since, and from what could be learned the road will be built.

A Sprague Road for Erie, Pa.

During this last week the Sprague Electric Railway & Motor Company, of your city, has closed a very important railroad contract at Erie, Pa. This contract calls for the equipment of the entire stock of the Erie City Passenger Railway, now operating twenty cars with over one hundred horses. The road is the only one in the city of Erie, and owns twelve miles of track, over ten miles of street. The electrical appliances will be of the finest description, and will embody all the latest improvements which have been introduced by the Sprague Company upon their railroads. At the central station there will be four dynamos of 50,000 watts capacity each, which deliver current to the line at an E. M. F. of 500 volts. The pole line will be of a neat and tasteful design and will carry the overhead system of wiring and light No. 6 wire as a working conductor.

The "Vacuum" Feed-Water Heater.

Users of steam will do well to investigate the merits of Webster's "vacuum" feed-water heater and purifier, which is spoken of highly by competent judges. Among the advantages it possesses are that it is most economical, and can be placed in any position, either near by or distant from the exhaust, and that it is low in price. The firm are receiving a large number of orders, particularly from electric light companies, and as they allow a thirty days' trial, in order to demonstrate its superiority, before asking payment, it is very evident that their confidence in their machine to do all that is claimed for it is very strong. Warren Webster & Co., of 491 North Third street, are the inventors, proprietors and manufacturers of the purifier and heater, which is the only vacuum machine in existence.

Dynamo Regulators.

Notice has been served by the Thomson-Houston Company upon all users of the American system that unless a satisfactory settlement is at once made under the recent decision in Boston proceedings will be taken to recover damages. Probably one of the largest interests to be affected, in point of territory, is the Wissahickon Electric Light Company, which has among its stockholders a number of City Councilmen and prominent politicians, who found a place on the ground floor when the enterprise was projected. This company supplies the suburban district of the 18th ward with the American electric light, and receives compensation therefor under a contract with the city of Philadelphia. Among the private consumers upon whom notice has been served is the proprietor of the National Theatre at Tenth and Callowhill streets, who has just finished a thorough renovation of that popular resort in the most regal style, and introduced a complete system of

electric lights generated from the American Company's plant. A large Chestnut street firm has a contract with the American Company, and comes within the purview of Judge Colt's decision. At the time the plant was introduced this firm demanded a bond from the contracting company to insure the house against just such a contingency as has arisen. The security was not forthcoming, and no settlement has yet been made between the consumer and the contractor. To further complicate matters in this particular instance, the debt has been garnisheed by the Edison Electric Light Company, which is a creditor of the American Company, and the question will probably lead to a troublesome and interminable law suit. E. W. E.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
44 Lakeside Building, Chicago, Sept. 3, 1888.

St. Charles, Mo.

The St. Charles Car Company, of St. Charles, Mo., which was recently reported as having purchased some other kind of lights for increasing their plant, have canceled that order and have just ordered 35 Excelsior lights.

St. Cloud, Minn.

Geo. Tileston, of St. Cloud, Minn., has purchased a small incandescent plant of the Thomson-Houston system.

Youngstown, O.

The Mahoning Electric Light Company, of Youngstown, O., are increasing their plant with 35 arc lights, which have just been ordered from the Thomson-Houston Company.

Wichita, Kan.

The Electric Light Company of Wichita, Kan., are putting in an incandescent central station plant that will start with 1,500 lights of the Thomson-Houston alternating system, which they have just ordered through the Western department of the Thomson-Houston Company.

The Fort Wayne Jenney Company

have just moved into new quarters at 185 Dearborn street, ground floor, where they will occupy large and elegant offices.

Mr. R. T. McDonald, manager of the company, was in the city this week, and he informs me that his company are very busy in making new installations.

At Bloomington, Ill., the company are putting in a plant of 210 arc lights.

A New Elevated Road Corporation.

A special from Springfield, dated Aug. 29, states that articles of incorporation for the Chicago Western Division Elevated road was recorded in the Secretary of State's office, the capital stock to be $10,000,000. The board of directors are Andrew Onderdonk, New York; James Ross, Sherbrooke, Quebec; Wm. D. Howard, John J. P. Odell, James Deering, George S. Willits and Wm. G. McCormick, of Chicago. Henry B. Robbins and Chas. L. Brooke are incorporators, but not members of the board of directors.

For Reduced Telephone Rates.

The *Tribune* of Aug. 30 contains the following: A young man claiming to represent a firm of lawyers of some prominence, circulated a petition among the South Water street merchants and the wholesale grocery houses yesterday, asking the Common Council to reduce telephone rates to $75 per annum. He asked each petitioner to sign an agreement to pay $5 or $10 as the case might be, should the object of the petition be obtained. Signers to the agreement and to the petition were numerous. It is claimed that some of the aldermen are behind this scheme and expect to share in the profits of the firm whose agent is circulating the petition. It is known that some of the leading members of the council are determined to make one more effort to reduce the telephone rates as soon as the council reconvenes. The scalawag aldermen may think it a shrewd dodge to join in with the better element of the council, providing beforehand that they shall be rewarded for their services. The fact that so many signers were obtained indicates that if the council attacks the telephone monopoly it will have a large support.

Personal.

Mr. F. S. Terry, manager of the Electrical Supply Company, has just returned from a trip on his bicycle through Northern Illinois and Wisconsin. Among the points visited were Fox Lake, Geneva Lake, Waukesha and Oconomowoc. Hunting, fishing and boating were among the sports indulged in. A pleasanter time he says he never enjoyed, and he heartily recommends such a trip to any one who desires recreation in the fullest sense of the word.

Mr. W. H. McKinlock, secretary of the Central Electric Company, accompanied by his family, will make a hunting and fishing trip of two weeks to Mackinaw, by way of recreation.

Mr. C. F. Warner, manager of the Rockford Electric Power Company, made a short visit to the city this week.

A Large Wire Order.

Mr. W. H. McKinlock, of the Central Electric Company, returned this week from a trip "out West," bringing back with him an order for 300,000 feet (nearly sixty miles) of Okonite wire.

To Have an Electric Road.

It is reported that an electric street railway will be built in Peoria, Ill., soon. The system to be used is not decided.

A New Electric Mfg. Company.

The Royal Electric Company has been organized at Peoria, Ill., which will commence the manufacture of electric dynamos and motors. Their specialty will be mining work, they having a system especially adapted for power transmission in mines. Mr. C. W. Robertson, the manager of the company, was in the city this week on a short business trip. While here he was a visitor at the Electric Club.

The Excelsior Company.

The Chicago City Railway Company have just ordered of F. W. Horne, Western manager of the Excelsior Company, a 25-light machine for lighting the cable station on 57th and Cottage Grove. Prof. John E. Davies, of the State University at Madison, Wis., has just reported favorably upon the Excelsior system for use in that university, and they have placed an order for seven arc lights. The current is to be run into each classroom of the various departments and it will be used for both lighting and experimental purposes. It will be turned on or off at the pleasure of each professor in his classroom, thus making the machine liable to short circuits, a matter which is left entirely for the automatic regulator of the system to take care of, the company guaranteeing it to work in every case. John York, a drygoods merchant of this city, is building one of the finest drygoods stores in the city, corner of 20th and Halsted streets. It is to be lighted with Excelsior lights, which will be driven by a Corliss engine, manufactured by Hoffman & Billings, of Milwaukee, Wis., of 75 h. p. The Gore fire-proof hotel, at which place was held the recent reunion of the "Old-Timers," is lighted by 1,000 incandescent lights of the Excelsior system. A Beck automatic engine of 55 h. p., manufactured by the Taylor Manufacturing Company, has just been ordered, which will be used to run one of the dynamos during the day to supply current for the motors operating ventilating fans, etc.

Lightning at Cheyenne.

A special despatch from Cheyenne, Wyo., says: A herd of blooded horses owned by George D. Rainsford, the well-known horse raiser, was struck by lightning Friday last. Eighteen animals valued at $20,000 were killed outright. Rainsford, who was in the vicinity, was badly injured but is recovering.

The Electrical Supply Company.

While in conversation with assistant manager Taylor of the Electrical Supply Company, at their store, one day this week, I learned that their number of orders for goods was decidedly on the increase. The number of inquiries resulting from their advertisement in THE ELECTRICAL WORLD was last week more than three times the usual number of inquiries.

Isolated Plants in Tennessee.

The Memphis Lighting Company have just finished a Thomson-Houston incandescent plant for the Government Lighthouse steamer "Joseph Henry." The Edison Company have closed a contract with the De Soto Oil Company for a 40 light, 16 c. p. plant, and the Gayoso Oil Company are contracting this week for a similar installation.

Little Rock, Ark.

The Little Rock Edison Light and Power Company has been organized. A plant capable of running 1,200 incandescent lights will be installed, and a large number of lamps have already been contracted for by different firms. The cost of the original plant will be $20,000. Work on the new plant will commence as soon as the city grants a charter.

The Baxter Motor.

The Milwaukee Exposition, which opened this week, has ordered through the Western branch of the Baxter Electric Motor and Manufacturing Company, a full set of motors for driving the machinery during the Exposition. The motors ordered are of the new style, and have steel commutators. The sizes ordered are, two ½ h. p., two 1 h. p., two 2 h. p., and one 4 h. p. The management adopted the Baxter motor exclusively after having investigated the different kinds of motors with a view to establishing a miniature power station. The electric current is supplied from a dynamo which operates the power circuit and makes a complete power plant in itself. The Western branch of the company are this week installing one 10 and one 4 h.p. motors at Moline, Ill., and a ½ h. p. motor at Rock Island, and have, besides, assurances that two 10 h. p., one 4 h. p. and one 2 h. p. motors will be installed during the present month. In St. Paul they are also at present installing two 1 h. p. motors. Besides, the company have orders on file aggregating 45 h. p. more.

The Electric Machinery Company.

On Sept. 4 the Secretary of State issued license of incorporation to the Electric Machinery Company, of Chicago, capital stock $100,000. Incorporators, E. H. Haynes, Charles Steinbreiss and H. B. Cady.

Electric Light from Primary Batteries.

The Pennock Battery, Electric Light and Improvement Company are fitting up in a handsome manner at their offices in the Royal Insurance Building, 110 Quincy street, an exhibition plant. The apparatus is being put in place as fast as possible, and it is hoped to have the lights in operation by the 15th.

The United States Electric Lighting Company.

Mr. C. C. Warren, general manager of the Western Department of the United States Electric Light Company, who returned a few days since from a two months' trip abroad, informs me that the outlook for the electric light business is very bright for the coming fall. The business done by his department since the 1st of January, 1888, aggregates nearly as much as the entire year of 1887, and as the electric light season has only commenced, the prospect is that the business will be doubled. A number of large contracts have just been closed by the company. Through the courtesy of Mr. Warren I was recently shown through the store rooms of his department, which are in the basement directly below the offices occupied by him in the new Rookery building. Nearly everything in the line of apparatus used in connection with incandescent lighting is kept in these rooms. The store rooms comprise several large rooms, in which are kept dynamos, armatures, lamps, sockets, etc., and include draughting and shipping rooms. Much time is thus saved in the shipment of goods.

Telephone Quotations.

Col. S. G. Lynch, broker, 146 La Salle street, furnishes quotations upon telephone stock as follows:

Bell of Mo.	$150@	$155	Iowa Union	$27@	$28
Central Union	47@	48	Michigan	80@	81
Chicago	340@	345	Missouri and Kansas	70@	71
Colorado	44@	47	Rocky Mountain Bell	40@	45
Cumberland	65@	68	Wisconsin	110@	112
Great Southern	85@	40		E. L. P.	

THE TELEGRAPH.

Montreal, Can.—The Chief of Police has received instructions to raid every bucket shop in the city and arrest everybody in them.

Minneapolis, Minn.—The Minneapolis Electrical Subway Company has been formed by C. P. Lovell and others, with a capital stock of $800,000.

Boston, Mass.—The Commercial Union Telegraph Company, of Boston, Mass., has been incorporated by H. J. Pettengill and others, with a capital stock of $10,000.

THE TELEPHONE.

Kentucky.—A telephone line is to be built from Paducah to Benton and Smithland by Mr. Harman.

The Telephone Construction Company of New York has been organized by C. S. Beardsley and others with a capital stock of $30,000.

Down South.—The telephone line has now been completed by the Greenville and Luna Telephone Company, connecting Greenville with all important points on the Mississippi River between Arkansas City and Grand Lake, Ark. This line will, it is understood, be operated through the Great Southern Telephone and Telegraph Company's exchange at Greenville.

Nova Scotia.—In February last the Bell Telephone Company, of Canada, disposed of their business in the provinces of Nova Scotia and New Brunswick to the Nova Scotia Telephone Company, Limited, head office Halifax, N. S. Mr. J. H. Wagstaff, who was acting as district superintendent of Maritime Provinces for the Bell Company, was chosen general manager of the new company. This change places a new purchaser in the field, and manufacturers of electrical goods and telephone supplies would do well to send Mr. Wagstaff catalogues, price lists, etc.

THE ELECTRIC LIGHT.

Hinsdale, N. H., is making an effort to organize a local electric light company.

Rockmart, Ga.—It is said that an electric light plant is to be erected at Rockmart.

Abingdon, Va., votes this month on the question of lighting the town by electricity.

Paducah, Ky.—The proposed plant will be put in by G. J. Grammar and associates.

Statesville, N. C.—The city authorities have been negotiating for an electric light plant.

Glendale, S. C.—D. E. Converse & Co. are putting an electric light plant in their cotton mill.

New Utrecht, N. Y.—It is probable that electricity will be adopted for street lighting by the new Board of Improvements.

Morganton, N. C.—The hotel to be built by the Morganton Land and Improvement Company will have an electric light plant.

Chambersburg, Pa.—Mr. D. B. Kirby, clerk of the City Council of Chambersburg, Pa., will receive proposals for public lighting up to Sept. 10.

Boston, Mass.—The Boston Electric Light Company have recently ordered from the Brush Electric Company, of Cleveland, O., 25 double arc lamps of 2,000 c.p. each.

Fort Madison, Ia.—S. & J. C. Atlee, of Fort Madison, Ia., have recently increased their electric light plant by purchasing from the Brush Electric Company, Cleveland, O., a 45-light 1,200 c. p. dynamo.

Camden, N. J.—E. W. Tisdall, Philadelphia agent for the Brush Electric Company, has just concluded a contract with the Pennsylvania Railroad Company for a 500 incandescent electric light plant, to be installed in their shops at Camden, N. J.

New York City.—Stuyvesant Park is now lit by electricity, much to the delight of the public in its neighborhood. The East River Company supplies eight arcs at 35 cents per light all night and the United States Company eight more at the same rate.

New York City.—It was recently stated that two Fort Wayne Jenney alternating machines were to be placed in one of the stations of the New York Brush Illuminating Company. We are advised, however, that the report is quite without foundation.

The Thomson-Houston Current Regulator.—The United States Circuit Court for this district has granted an order to restrain the American Company from selling, delivering or shipping dynamos with the current regulator, in regard to which the suit was lately decided in favor of the former company in Boston.

Menominee, Mich.—The Menominee Electric Light Company, of Menominee, Mich., have recently purchased from Alex. Kempt, the Chicago agent of the Brush Electric Company, an incandescent electric light dynamo, with a full complement of lamps. This company is now burning in the neighborhood of 180 Brush arc lamps, with a large number of Brush incandescent lamps.

APPLICATIONS OF POWER.

Hot Springs, Ark.—The Hot Springs & Suburban Electric Street Railway Company have asked for a permit to build an electric street railroad.

Millboro, N. C., is likely to have two electric roads. Surveys have already been made for them. Messrs. R. P. Atkinson and R. T. Gray, of Raleigh, are interested.

Bangor, Me.—The work of laying the track for the Bangor (Me.) Electric Railway line is being prosecuted with vigor, and quite a piece of the road is already completed.

Danville, Va.—The Thomson-Houston Company has shipped a part of the material for the electric railway at Danville, Va., and the construction work will soon be commenced. The road is two miles in length, and four cars will be used.

Scranton, Pa.—The Scranton Passenger Railway Company has received two new motor trucks from the Thomson-Houston Electric Company, and two more are expected very soon. The construction work is being rapidly pushed forward and will be com-

pleted in a very short time. The road is two miles in length and four cars will be operated on it.

Des Moines, Ia.—The construction work on the electric railway at Des Moines has been begun. The Thomson-Houston system will be used.

Wichita, Kan.—The construction work on the electric railway of the Riverside Suburban Street Railway, of Wichita, Kan., has been begun. Three cars will be used on the road, which is two miles long. The Thomson-Houston system will be used.

Davenport, Ia.—The new power station for the Sprague electrical road in Davenport, Ia., will contain a 160 h. p. Hamilton-Corliss engine, with two 30 h. p. boilers and two Davidson pumps. The electrical equipment will consist of two 25,000 watt dynamos and two 30,000 watt dynamos. The building is so arranged that the electrical equipment of the company can be doubled, as it is the intention of the directors to supply outside parties with power as well as to generate enough for their own cars.

PERSONALS.

Mr. Enos M. Barton, president of the Western Electric Company, is expected home from Europe in a day or two.

Mr. E. G. Bernard, the well-known Sawyer-Man agent, is now a boniface, having invested in a snug hotel property at Utica, of which he is making a brilliant success in his leisure moments.

Mr. George W. Stockly is well known in electrical circles as president of the Brush Company, but it is not so well known that he is also president of the Young Men's Christian Association of Cleveland, which has a membership of about 1,600.

MISCELLANEOUS NOTES.

Poles in New York.—The Department of Public Works has now, it is stated, removed about 100 obstructive poles from the streets for the Subway Board.

A Correction.—In the article "On the Proper Resistance of Telephone Conductors," by Thomas D. Lockwood, appearing in a recent issue, two errors crept in. In the last line of the first column, p. 93, "No. 81 conductors" should evidently read "No. 18." And at the end of the next paragraph the phrase, "while we quadruple the resistance," should read "while we quadruple the *conductivity*."

Toledo, O.—The removal of the Libbey Glass Works from Boston to Toledo—now a leading natural gas city—is one of the events of the year. The works have been bodily transported, with hundreds of workmen, and are now in full blast at Toledo. The new factory covers four acres. The main buildings cost $50,000, and 50 car-loads of machinery were shipped from Boston. The transplantation was celebrated in Toledo by a big parade, and by an address of welcome from the Mayor of the city.

BUSINESS NOTICES.

The Mason Regulator Company, of Boston have recently received an order for 100 reducing valves from the Martin Car Heating Company; also for a large number of pump pressure regulators from the Whittier Machine Company for their elevator plants.

Jordan & Gottfried, 208 Canal Street, N. Y., carry a complete stock of iron and brass machine and wood screws, bolt, cap and set screws, taps, dies, files, twist drills, brass and rubber tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

Harrison Safety Boilers.—The Brown & Sharpe Manufacturing Company, of Providence, R. I., are now putting in another battery of Harrison safety boilers of 275 h. p. capacity. They have used this type of boiler since 1871, since which time they have given four orders, aggregating nine boilers of 665 h. p.

A Useful Pocket Handbook is that issued by the Washburn & Moen Manufacturing Company, and now in its sixth edition, giving in small compass a wonderful quantity of valuable information, practical, statistical, historical, etc., as to copper and iron wire in electrical work. It is distributed gratis, and ought to be in every vest pocket.

The Partz Electric Battery Company, of Philadelphia, having found their old quarters at 1,723 Chestnut street too small, have leased the large building at 636 Arch street, same city. They are now prepared to fill all orders promptly, and in addition to their large line of Open Circuit and Gravity and Motor Batteries, have a full line of small Motors and Dynamos. Send for their price list and catalogue, or write to them stating what you want.

Medical Batteries.—

ALBANY, Texas, Sept. 19, 1887.

Jerome Kidder Manufacturing Co., New York:

GENTLEMEN—I inclose postal note to cover last bill rendered. The platina came to hand safely, and I must again thank you for your promptness in filling my orders. The "Kidder Battery,' both galvanic and faradic, I regard as being the best, and I think the favorite in this part of the country. I have tried others, but like yours much the best. Very truly,

W. M. POWELL, M. D.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

PATENTS ISSUED AUGUST 21, 1888.

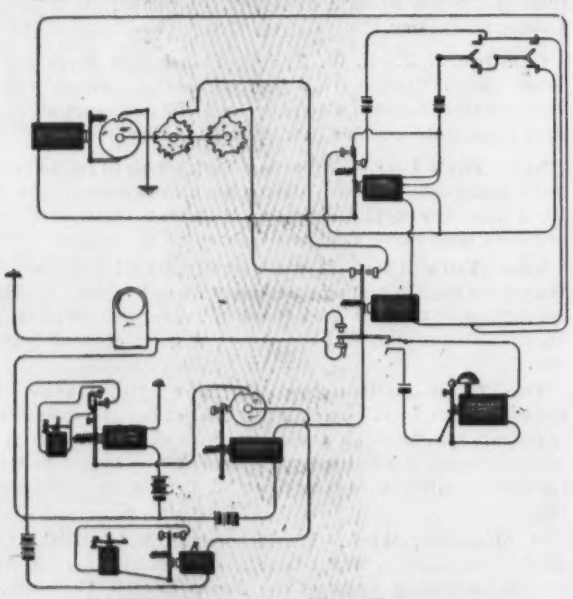
388,008. Electric Signaling; Clement Ader, of Paris, France. Application filed Jan. 26, 1888. Patented in England Dec. 20, 1887, No. 17,528. Claim. The combination with an electric signaling circuit divided into two branches of a telephone receiver in one of said branches, a local battery in circuit with said branches, and regulated to supply a current thereto of equal intensity with the currents normally arriving over the line, and a rheotome arranged to interrupt the circuit from said battery with a rapidity corresponding to the vibrations of an audible note.

388,023. Railway Signal; Thos. P. Curry, Danville, Ky. Application filed March 9, 1885. An operating rod for engaging with the signal rod is started into activity by a blow automatically delivered against the sustaining support of said rod.

(1) 388,052. (2) 388,283. Multiple Switch Boards; Milo G. Kellogg, Hyde Park, Illinois. Applications filed Nov. 9, 1887, and March 14, 1887, respectively. These patents relate to a system of testing at any board of the exchange to determine whether any line is in use at another board.

388,053. Arc Lamp; Virgil C. Killin, Chicago, Ill. Application filed March 24, 1888. Details relating to the apparatus for establishing and feeding the arc.

(1) 388,091. (2) 388,092. (1) Harmonic Telegraphy; (2) Telegraph Receiver; F. Van Rysselberghe, Brussels, Belgium. Applications filed Nov. 15, 1887, and Dec. 27, 1887,



388,358. AUTOMATIC FIRE TELEGRAPH.

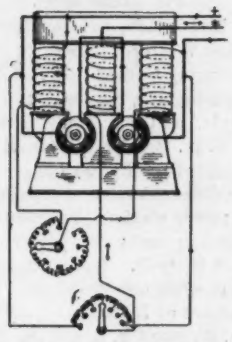
respectively. In a tone or harmonic telegraph, a tuning fork operated by the main line circuits, having an extension on said fork, a local circuit controlled by the extension and a telephone in the local circuit.

388,093. Dynamo-Electric Machine; M. Waddell, New York, N. Y. Application filed Feb. 27, 1888. The invention consists, mainly, in a dynamo-electric machine having two armatures revolving between opposite poles of a field magnet and a central regulating magnet whose pole is between the two magnets, and whose inductive effect is reversible and variable, whereby it may be made to exert a greater or less effect on either of the armatures. Thus, if the middle pole is magnetized with a north polarity, the electromotive force of one of the armatures is increased, while with a south polarity for the central magnet this effect is reversed. See illustration.

(1) 388,140. (2) 388,141. (3) 388,142, and (4) 388,144. Electrical Type Writer; James F. McLaughlin, of Philadelphia, Pa. Applications filed Aug. 24, 1887; Sept. 15, 1887; Oct. 18, 1887, and Oct. 18, 1887, respectively. These inventions have reference to improvements in electrical type-writers which are adapted for use both as transmitters and receivers if connected with similar instruments located at a different station, and as independent local instruments when not connected with the line.

388,181. Galvanic Battery; Howard Cassard, Baltimore, Md. Application filed Nov. 28, 1887. A galvanic battery consisting of a jar having an acidulated exciting fluid; a porous cell or bottle immersed in the same and containing an oxidizing agent, and an oxidizable metal and an electrode, both immersed in the same exciting fluid.

388,242. Pneumatic Intermittent Circuit Closer; Wm. C. Barney, New York, N. Y., Assignor to Josiah C. Reiff, of same place. Application filed Feb. 7, 1887. Claim: The combination, in a pneumatic instrument for sending intermittent impulses of electricity into a conductor, of a tympan in a case having an air-passage extending around the tympan, so that the air-waves will act first on one side of the tympan and



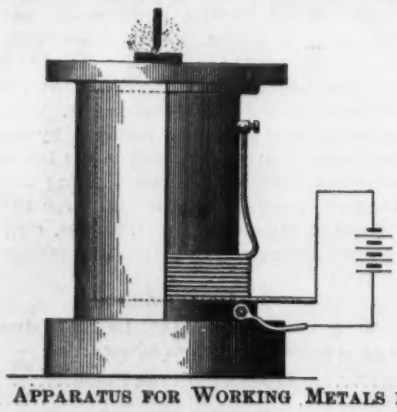
388,093. DYNAMO-ELECTRIC MACHINE.

afterward on the opposite side of it, an electrode in the centre of the tympan and at each side thereof connected with one pole of a battery, and two electrodes connected with the other pole of the same battery and placed opposite to each other and to the intervening electrode on the tympan. See illustration.

388,244. Printing Telegraph; Jean Maurice Emile Baudot, Paris, France. Application filed April 4, 1883. Patented in France, Jan. 6, 1882, No. 146,716; in Belgium, Jan. 25, 1882, No. 56,833; in England, Jan. 28, 1882, No. 436, and in Germany, Feb. 4, 1882, No. 20,826. A series of fingers with a combiner moving relatively to them and formed with rows of indentations (or equivalents) traversed by the fingers and arranged to be engaged by the latter according to as many different combinations as the characters to be transmitted.

(1) 388,245. (2) 388,246. Working Metals by Electricity; N. Benardos, St. Petersburg, Russia. Applications filed June 6, 1888. This is a method of working metals by means of the electric arc. The method consists in subjecting the arc to the influence of an electro-magnet, in the field of which the arc is maintained during the welding operation. See illustration.

388,247. Current Collector for Electric Railways; J. L. Blackwell, New York, N. Y. Application filed July 3, 1888. The invention consists in providing a vehicle so propelled with a supplementary contact device to be used in emergencies,



388,246. APPARATUS FOR WORKING METALS BY ELECTRICITY.

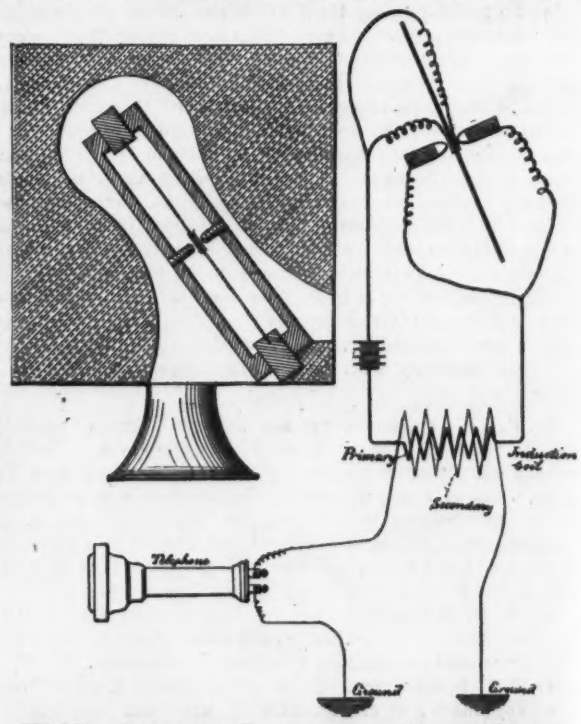
which is adapted to be inserted into the slot of a conduit and take the place of the normal contact device in case of accident. This supplementary contact device is provided with wheels by which it may ride upon the surface of the conduit, so that when it is brought into use no special attachment to the main vehicle is necessary, an ordinary hook or snap serving to draw it along the line.

388,294. Electric Gas Lighter; John J. McGowan, Ithaca, N. Y. Application filed June 24, 1887. An electric gas lighting apparatus organized with a cock and burner, a primary circuit-breaker connected to said cock and arranged to close the electric circuit when the gas is turned on, a gas lighter consisting of an electromagnet placed in that circuit and arranged to attract an armature, which in moving causes the circuit to be broken and the gas to be lighted by the resulting spark, and a secondary circuit-breaker arranged to break the circuit by the heating and consequent expansion by the gas flame of some of the parts of the secondary circuit-breaker.

388,300. Electric Steering Apparatus for Torpedo Boats; James O'Kelly, of London, and Bernard A. Collins, of 26 Machell road, Nunhead, County of Surrey, England. Application filed Jan. 3, 1888. In a torpedo, a rudder, a wheel for controlling the rudder and interlocking mechanism between the rudder wheel and propeller shaft controlled by an electro-magnet, a compass and a pivoted arm over the same, carrying the ends of said magnet's conductors, the said compass carrying a conductor adapted to contact with said arm and complete the circuit of the magnet.

388,312. Battery Zinc; Benj. Scarles, Clinton, Mass. Assignor of one-half to Charles Swinscoe, of same place. Application filed Feb. 17, 1888. An electrode for a galvanic battery composed of a number of zincs and a number of felts disposed in alternation, the zincs being connected by metallic connection.

388,333. Telegraph Receiver; Wm. T. Barnard, Baltimore, Md. Application filed April 30, 1887. A vibrating fork and a resonant body upon which the fork acts mechanically to produce the signals, and adjusting devices whereby the re-



388,242. PNEUMATIC INTERMITTENT CIRCUIT CLOSER.

sonant body may be adjusted so as to be struck by the vibrating fork when vibrating at its full normal speed, whereby the effects of induction may be avoided.

388,335. Secondary Battery; John Beattie, Jr., Fall River, Mass. Application filed May 2, 1887. The plates used in this battery are amalgamated throughout their entire bodies. One is composed of lead, arsenic, sodium and mercury, and the other of zinc, mercury, lead or tin and sodium.

388,344. Circuit-Closer for Call Systems; Chas. E. Dey, Denver, Colorado. Application filed April 19, 1887. This is an arrangement whereby either one or all of a number of push buttons upon a board may be operated by one motion. The design is to ring the bells in all of the rooms of a building simultaneously in case of fire or other danger.

(1) 388,357. (2) 388,358. Fire Telegraphs; John H. Guest, Brooklyn, N. Y. Applications filed May 25, 1887, and Oct. 27, 1887, respectively. The transmitting and receiving apparatus are included in branches from the main circuit. A magnet in the main circuit controls the operative condition of the receiving apparatus, while a circuit controller for governing the action of the magnet is located in the main circuit. See illustration.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1866—can be had for 25 cents. Give the date and number of patent desired, and address Johnston's Patent Agency, Potter Building, N. Y.